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IN THEIR APPLICATION TO

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EDITORIAL.

WE ARE embarked upon a new era — last year was a sore trial to all — scientist, business man, and manual worker. With the ratification by the U.S. Senate of the Hoover Plan for postponement of international debt payments as from 1st July last, the world is now *again* hoping and working for the ever-present and all-troublesome war debt question to be discussed with a view to final adjustment. If this could only be brought about it would appear that trade would materially improve and better understanding among the nations ensue.

Last year more than ever it appeared that finance and science are becoming more reconciled. Finance seems to realise that research and investigation is the genesis of all new business, both in industry and on the Stock Exchange. A pleasing feature, which may be a portent of better times, is Sir Eric Hambro's visit this week to the various coalfields of England in order to ascertain the prospects and the feelings of employers and workers in connection with his proposed financing of the Salerni process of low temperature carbonisation. Sir Eric hopes to visit South Wales, the Midland coalfields, Lancashire and Yorkshire, at least, but at the moment his detailed itinerary is not settled. If a plant was laid down in each area, it would naturally mean increased employment and we must look for the day when this new industry will be in full swing.

At the Conference on Experimental Biology held in London just before Christmas, an interesting line of thought was opened up, which may, if duly prosecuted to its ultimate conclusion, lead to a new theory of man's descent. The question raised was, whether bio-chemistry, more particularly in relation to recent developments in the study of chemical change taking place in animals, may not play as important a part as morphology in tracing man's descent. Dr. Joseph Needham has carried out long and important research into the distribution of certain compounds of phosphorus in animals, and his work has indicated the important factor the substance plays in the higher animals and its comparative absence in the lower orders in the animal kingdom. If further research is carried out in this connection bio-chemistry as a definite science may establish itself and the scorn poured upon it by many pendantic scientists may rebound upon the utterers.

The amount of international research accumulated from last year and carried forward into this is nothing short of prodigious. With world economic warfare rampant the research workers of all nations are working as they have never worked before and reports to hand disclose the fact that the present year will be notable for its advance in scientific knowledge.

In this issue we publish the names of our new Editorial Board. The Board has come into being because of the necessity of world-wide representation. Through the medium of this Board first-hand information will be passed to the CHEMICAL NEWS and papers and contributions will be vetted by experts in their own particular field.

All members of this Board, in addition to being well-known as contributors to scientific literature, are active in the field of practical research.

The policy of the CHEMICAL NEWS is such that arm-chair science cannot be tolerated. Experimental research is the only instrument by which knowledge can be increased and arrangements have been made whereby that advancing knowledge will appear from time to time within its pages.

Dr Arthur Harden has revised and brought up-to-date his well-known monograph on Alcoholic Fermentation, which was first published twenty years ago. The scope of this new edition remains the same as in former editions, but it also contains an account of the extensive researches which have been made during the past eight or nine years. It will be published shortly by Longmans.

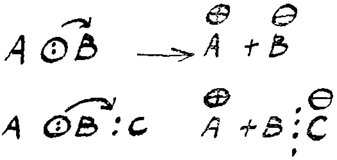
SOME APPLICATIONS OF THE ELECTRONIC THEORY OF VALENCY

PART VII. THE PROBLEM OF AROMATIC SUBSTITUTION.

By PROFESSOR R. F. HUNTER, D.Sc.(Lond.), Ph.D., D.I.C., A.R.C.S.

Director of the Chemical Laboratories of the Aligarh Muslim University and Vice-President of the Muslim Association for the Advancement of Science.

One of the most interesting applications of the electronic theory of valency, has been furnished by the old problem of the directive effect of groups in aromatic substitution. Before discussing this, however, it is desirable to refer to certain fundamental points in connection with the application of electronic principles to this problem . . . Now there are two chief ways in which a compound can undergo decomposition, namely, by *ionisation* and by a *retrograde* 1 : 2-addition, which correspond electronically with the appropriation of a duplet, either by a single atomic nucleus or by two nuclei acting in conjunction :—



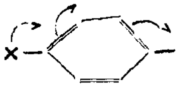
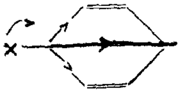
A predisposition to reactivity can then be regarded to a force acting upon a given duplet in such a way, that if it could actually move it, it would move it in one of the directions illustrated in the diagram above.

For the full comprehension of this we must assume that the electronic orbits are slightly displaced in these directions, because the periodicity in the optical properties of compounds could not arise unless the electrons were held with elastic restraints. Small shifts of this type alter the screening action of the electron groups surrounded by adjacent atomic nuclei, and this gives rise to that reactivity which can be propagated from one atom to another along a chain. The application of these principles to the problem of aromatic substitution has received most remarkably successful results at the hands of Robinson and Ingold.

If we adopt the view that chemical reactivity is due to loosely held electrons, it appears from the relative velocities of o-p-substitutions as compared with meta substitution, that o-p-directing groups repel certain electrons of the benzene nucleus, whilst m-orienting groups attract electrons from the benzene nucleus. This is consistent with the known orienting effect of charged atoms whose action on electrons is more or less independent of the theory of stable groups and is immediately deducible from the sign of the electrostatic charge in that positive and negative poles represent the most powerful known meta and ortho-para directing influences.

As is well known, Flurscheim's alternation of affinity theory and Vorlander's theory of alternately polarised atoms although they frequently prove remarkably successful in interpreting experimental results in Organic Chemistry, frequently lead to certain inconsistencies. In the first place, obvious difficulties are presented by the fact that whatever may happen within the benzene ring itself, there is frequently a definite absence of alternation in the side-chain attached to an aromatic nucleus.

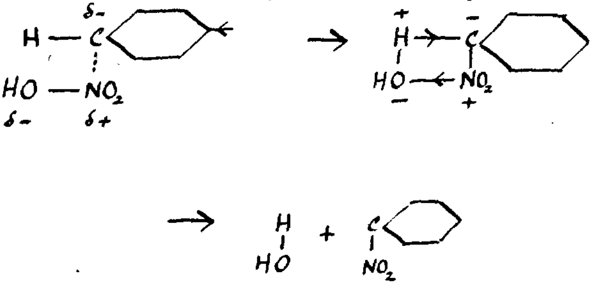
If we regard o-p-substitution as being caused by the formation of residual affinities, represented by loosely held electrons in these positions, the electronic interpretation will be, that relatively to hydrogen the o-p-directing atom X allows its electrons to come more under the influence of the positive atomic nucleus of the adjacent carbon atom, with a corresponding loss of control of electrons which are held in conjunction with the *ortho* carbon atom (I). The *para* position can be reached by mutually accommodating adjustments of electrons from the two double bonds of the Kekulé phase, but a more satisfactory interpretation would appear to be obtained by the conception of direct *para*-affinity exchange by means of the Dewar phase of the benzene nucleus (II).

(I)   (II)

Indeed the Dewar phase is a most satisfactory means for expressing the case with which electrical disturbances reach the para position, in view of the fact that orienting electrical disturbances suffer severe damping in passing through a double linking in a side chain.

With regards to meta substitution, it must be emphasised that whilst o-p-substitutions are often practically instantaneous at ordinary temperatures, meta substances are notoriously slow, and a conception which is not altogether new is, that m- substitution is a *residual effect* produced by the disappearance of free affinity from the ortho and para positions, which may arise from the reversal of the processes represented in (I) and (II). As Ingold has pointed out, this explains why it is that in the absence of other disturbances, a weak o-p-directing group outweighs a strong meta directing group in competition, and why further substitution in a mono-substituted naphthalene containing a meta directing group in one nucleus, occurs in the unsubstituted ring.

Now, if we accept the theory of residual affinities due to loosely held electrons as in (I) and (II), it is clear that after the preliminary attachment of the reagent molecule has occurred, some much more powerful factor operates which carries the process to completion by a comparatively direct route. In nitration for instance it seems probable that the tendency for hydrion and hydroxide ion to form undissociated water is the driving force, and the process of nitration can be represented diagramatically as follows, where δ+ and δ− denote fractional positive and negative charges, and the arrows represent the directions of electron displacement :



In this connexion, it is possible that the reason why hypochlorous acid chlorinates more readily than it oxidises aromatic compounds is that the tendency to form undissociated water is greater than the tendency to form ionising hydrogen chloride.

It will be noticed that this picture of aromatic substitution, assumes the preliminary addition of an *incipiently* ionised molecule. The other alternative would be to assume that a small part of the reagent is fully ionised and that the attack is made by the positive ion of the reagent molecule; and as regards its face value this seems to be quite a reasonable hypothesis because there are recorded cases of nuclear attack by positive ions such as the diazonium ion. As far as chlorination by hypochlorous acid goes, however, the problem has been recently settled by Soper and Smith, who have shown by dynamic methods that in the chlorination of phenol, the reaction takes place between the phenoxide *ion* and the hypochlorous acid *molecule*.

Aligarh Muslim University,
United Provinces,
India.

FACTORS FOR CONVERTING PERCENTAGES OF NITROGEN IN FOODS AND FEEDS INTO PERCENTAGES OF PROTEINS.*

By D. Breese Jones.*

The importance of proteins in the diet is generally recognised. Both the quantity and the quality of protein are matters of importance to everyone, particularly to dietitians, physicians, housewives, school and institutional workers, food and feed manufacturers, and animal husbandrymen. Unless the diet contains enough protein of satisfactory quality proper nutrition will not result. An excess of protein, on the other hand, is at least uneconomical, because protein is the most costly of the food elements. The percentage of protein in a feed largely determines its price. Wheat is now commonly bought on the basis of its protein content. It is, therefore, desirable to have as accurate knowledge as possible of the quantity of protein in various materials.

Proteins have been defined as nitrogenous chemical compounds of great molecular weight which give colloidal solutions and which on analysis yield amino acids as cleavage products.

Without proteins there can be no life. They play a predominating rôle in the life process of every cell. Proteins enter into the construction of nearly all animal tissues and form the chief constituent of many of the body fluids. Aside from their rôle in nutrition, they are connected with many physiological processes in health and disease. Serums, toxins, antitoxins, sensitisation, immunisation, allergy—terms familiar in the modern practice of medicine—are largely interpreted in terms of protein.

Fat, carbohydrate, ash, and moisture in food materials can be determined with a high degree of accuracy, but the method used for estimating protein is unsatisfactory. The percentages for protein given in books and tables showing the composition of foods are merely a form of expressing the total nitrogen, and in many cases are far from representing the correct values for real protein.

The new protein conversion factors now given are based upon the most reliable information available regarding the nature and composition of the proteins in the materials concerned. Although it is realised that their use will not give values which will express the quantity of protein in the different food materials with absolute accuracy, it is believed that they will give values representing the real protein content more closely than those obtained by the indiscriminate application of the factor 6.25, now in general use.

*(Of the U.S. Department of Agriculture.)

Estimation of Protein in Foods and Feeds.

In order to produce a mixture of several ingredients that will contain a given quantity of protein from known sources, it is obviously necessary to know the percentake of protein in each of the several ingredients. This is ascertained by referring to tables which give the percentages of protein, fat, and carbohydrate in different food materials. The percentages of proteins as there given are then used in calculating the quantity of each constituent necessary in order that the mixture shall contain the required quantity of protein.

Many users of food-composition tables will doubtless be somewhat surprised to learn that the percentages given for protein in different foods represent the nitrogen content, and in only a few cases do they represent the actual protein. In many cases the percentages given for protein are far from correct, and are likely to be misleading. Much has been detracted from the practical and scientific value of many experiments in which the quantity of protein in the ration or diet has been calculated only on the basis of nitrogen content.

In biological tests, unless pure, isolated protein is being used, or the effect of non-protein is eliminated, would it not be more accurate to speak of the protein value of corn, for instance, rather than the biological value of its protein?

The quantity of protein in materials can not be determined with expediency by separating and weighing the pure protein as is done with fats and other food constituents. The great difficulty and time-consuming labour involved in the quantitative isolation of proteins in a pure condition absolutely preclude this method. Instead, the percentage of protein in a material is calculated from the quantity of nitrogen it contains. The nitrogen is usually determined by the Kjeldahl method or some modification of it.

All proteins contain nitrogen. Many years ago, when the comparatively few proteins known were chiefly of animal origin, such as serum albumin and serum globulin from blood and casein from milk, it was found that these proteins contained about 16 per cent. nitrogen. On the assumption, therefore, that proteins in general contained 16 per cent. nitrogen, the proctice originated of estimating the percentage of protein in nitrogenous food materials by multiplying the percentage of nitrogen by the factor 6.25 (100 ÷ 16). With but few exceptions, the percentages of protein in foods as given in food-composition tables have been calculated in this way; that is, by multiplying the percentage of nitrogen by the factor 6.25.

This method of estimating protein rests on two assumptions, neither of which is necessarily correct. In the first place it assumes that all the nitrogen in food material is protein nitrogen. It is known, however, that in many, if not in most cases, nitrogenous substances are present which are not proteins nor related to proteins. In the second place it assumes that all proteins contain 16 per cent. nitrogen.

Nonprotein Nitrogen in Foods.

In connection with the first assumption referred to, it is obvious that an estimation of the percentage of protein based on the nitrogen content of a material can not be accurate if that material contains nitrogenous constituents other than protein. There are few, if any, naturally occurring nitrogenous substances that do not have constituents other than protein which also contain nitrogen. An estimation of protein based on total nitrogen content will, therefore, give values that are too high. The following two cases may be taken as illustions. Only one-third to one-half the nitrogen of the common potatoe has been accounted for as protein. Concerning the nature of the remaining nitrogen in the potatoe but little is known. It has been shown, however, that a considerable proportion of this nonprotein nitrogen belongs to asparagine. Potatoes therefore, may contain not 1.5 to 2 per cent. of protein (nitrogen × 6.25), as given in tables showing their composition, but only one-half, or less, of that amount. Again, alfalfa, an important feedstuff, and one of the very few substances the nature of the total nitrogen of which has been systematically investigated, has been shown to contain a number of nitrogenous compounds which are not even related to protein. The following are some nonprotein compounds containing nitrogen that have been isolated from alfalfa leaves: Stachydrine, asparagine ,choline, adenine, trimethylamine, betaine, arginine, lysine, tyrosine, aspartic acid, alanine, valine, leucine, phenylalanine, serine and glutamic acid. Unquestionably there are other nonprotein compounds in alfalfa that have not yet been discovered. Here again as in the case of potatoes it is evident that the protein percentage calculated on the basis of total nitrogen must be far too high.

The statement is sometimes made that, from a nutritional standpoint, the nonprotein nitrogenous compounds in food materials may have a value quite equal to that of protein itself, and that, for this reason, it is immaterial whether the protein content is based on the total nitrogen or on the actual protein present. This might be true, if amino acids were the only nonprotein compounds involved. But, as is well known, a large number of nitrogenous compounds exist, both in plant and animal material, which can not replace protein in the diet.

Nitrogen Content of Different Proteins

As pointed out in the preceding paragraphs, the error involved in estimating protein upon the basis of total nitrogen unfortunately can not be corrected until much more information is available regarding the nonprotein constituents. With reference, however, to the second source of error in estimating protein, namely, that arising from the indiscriminate use of the conversion factor 6.25, we do have data which can be applied for the calculation of factors that will give results representing more nearly the true protein content. The chief proteins in most of our common food materials have been isolated and studied. The percentage of nitrogen in these proteins is definitely known.

In Table 1 is given a list of different proteins that have been isolated from plant and animal sources, and the percentages of nitrogen which these proteins contain. Most of the proteins listed have been prepared and analysed many times.

TABLE 1.—*Nitrogen content of various proteins.*

Source	Protein	% N
Adsuki bean	α-Globulin	15.6
	β-Globulin	16.5
	Legumelin	16.3
Almond	Amandin	19.3
Alfalfa leaves	Protein	15.8
Avocado	Salt-soluble protein	15.3
	Alcohol - alkali - soluble protein	13.4
	Alcohol-soluble protein	16.2
Barley	Hordein	17.2
	Globulin	18.1
	α-Glutelin	16.2
	Albumin	16.6
Blood	Serum globulin	16.2
	Serum albumin	16.0
	Hemoglobin	16.3
	Fibrin	16.9
Brazil nut	Excelsin	18.3
Buckwheat	Globulin	17.4
Butternut	do	18.6
Cantaloupe seed	do	18.4
Castor bean	do	18.8
	Ricin	16.6
Chicken	Muscle fibre	16.1
Cohune nut	Globuliu	17.8
Corn	Zein	16.1
	Glutelin	16.1
	Globulin	18.0
Corn leaves	Protein	14.4
Coconut	Globulin	18.5
Cottonseed	α-Globulin	18.2
	β-Globulin	17.8
Cowpea	Vignin	17.2
	Legumelin	16.4
Durum wheat	Prolamin	17.5
Eggs	Ovalbumin	15.5
	Conalbumin	16.1
	Vitellin	16.3
	Livetin	15.1
Einkorn	Prolamin	16.7
Emmer	do	17.6
Filbert	Corylin	19.2
Fish (halibut)	Muscle fibre	16.5
Flaxseed	Globulin	18.5
Gelatin	Gelatin	18.0
Hazelnut	Corylin	19.1
Hempseed	Edestin	18.7
Jack bean	Canavalin	16.7
	Concanavalin	16.4
Kafir	Kafirin	16.6
Lentil	Legumin	18.1
	Vicilin	17.4
	Legumelin	16.3
Lima bean	α-Globulin	15.5
	β-Globulin	14.8
	Albumin	14.2
Locust tree bark	do	14.8
Lupine	Conglutin	18.0
Marigold seed	Globulin	16.9
Maple seed	Acerin	18.8
Milk (cow's)	Casein	15.9
	Lactalbumin	15.4
	Alcohol-soluble protein	15.7
Mung bean	α-Globulin	15.7
	β-Globulin	16.7
Navy bean	Phaseolin	16.1
	Conphoseolin	15.7
Oat	Prolamin	16.4
	Glutelin	17.5
	Globulin	17.9
Ox (flank)	Muscle fibre	16.2
Pea	Legumin	18.0
	Legumelin	16.8
	Vicilin	17.4
Peach kernel	Globulin	19.3
Peanut	Arachin	18.3
	Conarachin	18.2
Potato	Tuberin	16.4
Raddish seed	Globulin	18.2
Rapeseed	do	17.0
Rice	Globulin, coagulable at 74° C.	16.3
	Globulin, coagulable at 90° C.	17.9
	Oryzenin	16.8
	Prolamin	16.2
Rye	Gliadin	17.7
	Glutelin	16.7
	Albumin	16.7
Scallop	Muscle fibre	17.0
Sesame seed	α-Globulin	18.4
	β-Globulin	17.6
Shrimp	Muscle fibre	16.9
Silk	Sericin	15.9
	Fibroin	18.0
Soybean	Glycinin	17.5
	Legumelin	16.1
Sorghum	Prolamin	14.3
Spelt	do	17.0
Spinach	Spinacin	16.2
Squash seed	Globulin	18.5
Sunflower seed	do	18.6
Sweetpotato	Ipomoein	16.2
Teosinte	Prolamin	15.9
Tomato seed	α-Globulin	18.3
	β-Globulin	16.0
Velvetbean, Gerogia	α-Globulin	16.6

Source	Protein	% N
	β-Globulin	17.3
	Albumin	15.9
Velvetbean, Chinese	Stizolobin	16.3
Vetch	Legumin	18.0
	Legumelin	16.2
Wheat endosperm	Gliadin	17.6
	Glutenin	17.5
	α-Glutelin	17.1
	β-Glutelin	16.1
Wheat germ	Leucosin	16.8
	Globulin	18.3
	Proteose	17.0
Wheat bran	Prolamin	15.3
	Globulin	17.7
	Albumin	15.4
Walnut, English	Juglansin	18.9
Walnut, black	do	18.9

Errors Arising from the Use of Wrong Conversion Factors.

As shown in Table 1, the nitrogen content of different proteins varies within a rather wide range. Some proteins that have been isolated contain as little as 13 per cent. nitrogen; others contain more than 19 per cent. As an illustration of a possible error in calculating the protein content of a single food material by using the factor 6.25, take the case of almonds. The protein content of the edible portion of almonds is usually given in tables showing the composition of foods as 21 per cent. This figure is obtained in the conventional manner by multiplying the nitrogen content of almonds, 3.36 per cent., by the factor 6.25. However, the protein of almonds consists of a globulin named amandin, containing 19.3 per cent. of nitrogen. This protein has been isolated in crystalline form (90) and has been extensively studied. No other protein has been found in significant quantities in this seed, and it has but little non-protein nitrogen. Its nitrogen content, 19.3 per cent., corresponds to the factor 5.18. If the factor 5.18 be used, which corresponds to the actual percentage of protein nitrogen in almonds, instead of the conventional factor 6.25, the percentage of protein in almonds will be found to be 17.4 per cent. instead of 21 per cent.

Even more striking is the discrepancy in the case of gelatin. Its protein content is given as 91.4 per cent. (N × 6.25). However, when the factor 5.55 is used, which is the one corresponding to the actual nitrogen content of gelatin, the protein content will be found to be 81.2 per cent. Striking differences in the figures for other food materials are shown in Table 6.

The chief proteins in most vegetable material contain more than 16 per cent. nitrogen. This is particularly true of seed proteins. Many seeds, however, do contain besides the one or two chief proteins, one or more other proteins in smaller quantities, which almost invariably contain less nitrogen. If only those proteins which make up the greater part of the protein content of vegetable material be taken into consideration, the average percentage of nitrogen in them is about 17 per cent. This corresponds to the conversion factor 5.84. When the percentages of protein in most foods of vegetable origin, with the possible exception of green vegetables, fruits, and tubers, are being calculated, this factor, therefore, would give the true protein content more closely than the factor 6.25, which is now used. There are certain foodstuffs concerning the proteins of which sufficient is known to justify the use of special nitrogen conversion factors. Although in most cases even these factors will not give absolutely correct figures for protein content, they will give them more accurately than the arbitary factor 6.25. Even for substances the nitrogen of which is known to be protein nitrogen, and for which the relative proportions of the different proteins have been fairly well established, available data are not sufficiently complete for the calculation of perfectly correct factors.

Proteins of Cereal Grains.

Wheat.

The factor generally used for wheat flour and for the whole wheat kernel 5.7, is based on the nitrogen content of the two principal proteins in flour namely, gliadin and glutenin.

However, flour has a protein content about 1 per cent. lower than that of the wheat from which it is obtained. This has been assumed to be due to the fact that bran contains a higher percentage of protein than the endosperm. Work done in the Bureau of Chemistry and Soils on the proteins of wheat bran has shown that this is only one cause. The other cause of the lower protein content of the flour as com-

pared with that of the wheat from which it is made is that the proteins of bran have not the same nitrogen percentage as the proteins of flour. Two of them have a lower percentage. The nitrogen of bran represents approximately 22 per cent. of the total nitrogen of wheat. From a commercial wheat bran from which nearly all the adhering parts of the starchy endosperm had been removed by special treatment, three proteins were isolated, an albumin, a globulin and a prolamin. These proteins were obtained in percentages of 2.87 2.35, and 5.35, respectively, which amounted collectively to 10.57 per cent. of the bran. They have been studied extensively with regard both to their chemical composition and properties and to their nutritive value.

The results of these studies have raised the question whether or not a factor based not only on the nitrogen content of gliadin and glutenin, but also taking into account the proteins of the bran and the embryo, would give the protein content of wheat more accurately than the customary factor 5.7. Special interest lends itself to this matter in view of the current practice of buying wheat upon analysis and determination of its protein content. Accordingly, the factors have been calculated for converting the percentages of nitrogen in the endosperm, embryo, and bran into terms of protein. On the basis of the nitrogen percentages in these different parts of the seed and of their relative distribution in the wheat kernel, a factor has been obtained for the conversion of the nitrogen of the whole kernel into terms of protein.

Endosperm.

The proteins of the endosperm consist chiefly of gliadin and glutenin, which occur in wheat in approximately equal quantities. Although traces of a globulin and albumin have also been isolated from flour, it is questionable whether these small quantities found in the best flour may not be due to the presence of small quantities of embryo that escape separation in the milling process. At any rate, the quantities are too small to affect the results significantly when considering the conversion factors for the endosperm nitrogen. Gliadin contains about 17.6 per cent. of nitrogen, and glutenin about 17.5. The endosperm proteins collectively, therefore, contain 17.55 per cent. of nitrogen, which, divided into 100, gives the conversion factor 5.698, or 5.7, which is the factor generally used for the conversion of nitrogen into protein percentage not only in flour, but also in whole wheat.

Bran.

The proteins of bran have been shown to consist essentially of an albumin, a globulin, and a prolamin.

On this basis the bran proteins collectively contain 15.86 per cent. of nitrogen, corresponding to the conversion factor 6.31.

Embryo.

Osborne and Campbell obtained from wheat embryo about 10 per cent. of albumin, 5 per cent. of globulin, and 3 per cent. of proteose, which contain 16.8, 18.3, and 17.0 per cent. of nitrogen, respectively. Calculated on the basis of these figures, the embryo proteins as a whole contain 17.24 per cent. of nitrogen, corresponding to the conversion factor 5.80.

Whole Wheat Kernel.

In their classic work on the nutritive value of the wheat kernel and its milling products, Osborne and Mendel have estimated the percentages of the total protein of the wheat kernel which is contained in the endosperm, bran, and embryo as follows: Endosperm, 73.3 per cent.; bran, 22.3 per cent.; embryo, 4.4 per cent.

These figures are based on approximate proportions of the above-named parts in the average moisture-free wheat kernel containing 2.2 per cent. of nitrogen. The authors state: "The relative proportion of these parts varies somewhat in different samples of wheat, but in general we believe that these figures fairly represent the average."

By taking into account the foregoing proportions of the parts in the seed, the relative quantities of the different proteins which have been isolated from these parts, and the percentages of nitrogen in the proteins, the conversion factor for the nitrogen of the whole wheat kernel may be calculated in the following manner:

Total nitrogen in 73.3 grams of endosperm proteins:

	grams
73.3×0.1755	12.864

Total nitrogen in 22.3 grams of bran proteins:

$$\frac{2.87 \times 22.3 \times 0.154}{10.57} = 0.9325 \text{ gram albumin nitrogen.}$$

$$\frac{2.85 \times 22.3 \times 0.177}{10.57 \text{ nitrogen}} = 0.8775 \text{ gram globulin}$$

$$\frac{5.35 \times 22.3 \times 0.153}{10.57 \text{ nitrogen}} = 1.7269 \text{ grams prolamin}$$

	grams
Total	3.537

Total nitrogen in 4.4 grams of embryo proteins :

$$\frac{10 \times 4.4 \times 0.168}{18 \text{ nitrogen}} = 0.411 \text{ gram albumin}$$

$$\frac{5 \times 4.4 \times 0.138}{18 \text{ nitrogen}} = 0.224 \text{ gram globulin}$$

$$\frac{3 \times 4.4 \times 0.17}{18 \text{ nitrogen}} = 0.125 \text{ gram proteose}$$

	grams
Total	0.760

Total nitrogen in 100 grams of total wheat proteins 17.161

$100 \div 17.161 = 5.83$ conversion factor.

The conversion factor 5.83 thus obtained is based partly on the relative proportions in which the proteins have been isolated from the different parts of the seed. The quantities actually isolated, however, probably do not represent all the protein present, especially in the embryo and the bran. It is seldom that the proteins in a naturally occurring plant or animal product can be completely extracted. Furthermore, more or less unavoidable losses are always involved in the separation and isolation of the proteins after they have been extracted from the material which originally contained them. Such losses are usually, however, rather uniformly distributed among the different proteins of the seed and would therefore not significantly affect the conversion factor.

In Table 2 are given the nitrogen-conversion factors for some food substances concerning the proteins of which, it is believed, there is sufficient knowledge to justify the use of special factors for converting the percentages of nitrogen into that of protein. Although it should be understood that these factors will not give absolutely correct values, for the reasons that have been already discussed, it is believed that they will give the true protein content more accurately than will the indiscriminate use of the convenional facor 6.25.

TABLE 2.—*Factors suggested for converting percentages of nitrogen into terms of protein*

Subs.	Factor suggested
Cereal grains :	
Wheat, endosperm	5.70
Wheat, embryo	5.80
Wheat, bran	6.31
Wheat, whole kernel	5.83
Rye	5.83
Barley...	5.83
Oats	5.83
Rice	5.95
Corn (maize)	6.25
Oilseeds and nuts :	
Hempseed	5.30
Cottonseed	5.30
Sunflower seed	5.30
Flaxseed	5.30
Squash seed	5.30
Pumpkin Seed	5.30
Sesame seed	5.30
Cantaloupe seed	5.30
Almonds	5.18
Coconut	5.30
Brazil nut	5.46
Hazelnut	5.30
Walnut	5.30
Peanut...	5.46
Soybean	5.71
Butternut	5.30
Castor bean	5.30
Substances of animal origin :	
Milk	6.38
Eggs	6.25
Meats	6,25
Gelatin	5.55
Leguminous seeds :	
Navy bean...	6.25
Lima bean	6.25
Mung bean...	6.25
Velvetbean	6.25
Aduski bean	6.25
Jack bean	6.25

For comparison, in Table 3 are shown the percentages of protein (N × 6.25) in some common food materials as given in standard food-composition tables and the percentages obtained for the same material as calculated on the basis of the conversion factors given in Table 2. There is a marked difference in the protein percentages in most cases. For gelatin, the difference is more than 10 per cent. Nuts present differences of from 2 to 4 per cent.

TABLE 3.—*Percentages of protein in some food materials calculated with the factor 6.25 as compared with the values derived when using corrected factors.*

Material	% Protein based on 6.25	% Protein based on special factors
Almonds	21.0	17.4
Barley meal and flour ...	10.5	9.8
Bread from high-grade patent flour	8.7	7.9
Buttermilk	3.0	3.1
Butternuts, edible portion	27.9	23.6
Brazil nuts, edible portion	17.0	14.8
Cheese, American pale ...	28.8	29.4
Cheese, cottage	20.9	21.3
Coconut, edible portion...	5.7	4.8
Coconut, prepared, as purchased	6.3	5.3
Filberts, edible portion ...	15.6	13.2
Flour, entire wheat ...	13.8	12.9
Flour, patent, bakers grade	13.3	12.1
Gelatin	91.4	81.2
Hickory nuts, edible portion	15.4	13.1
Milk, whole	3.3	3.4
Milk, skimmed	3.4	3.5
Milk, condensed	8.8	9.0
Oatmeal	16.1	15.0
Peanuts	25.8	22.5

The lower figures for gelatin and nuts are believed to represent closely the actual protein content. Gelatin is known to contain about 18 per cent. nitrogen, and most of the nitrogen in nuts occurs in the globulin fraction, which contains approximately 19 per cent. nitrogen. Although special conversion factors are sometimes used for a few materials, notably wheat and wheat products, milk and milk products, and gelatin, it should be emphasised that the factor 6.25 is the one that has been used in the preparation of nearly all food-composition tables that are in general use.

CORROSION FROM SEA-WATER.

BEST METHOD OF PROTECTION.

By A WELL KNOWN ENGINEER.

The strongly corrosive properties of sea-water are well known especially as regards iron and steel, and in this connection a most important contribution by Oberingenieur Andreae of the famous German shipbuilding firm of Blohm and Voss (Hamburg) has recently appeared in "Korrosion und Metallschutz" (Berlin). There is given on most elaborate lines the results of the extensive practical experience of the above firm in struggling to prevent the corrosion of iron and steel in connection with ships, as well as the deterioration of condenser tubes, propellers, and other equipment made of the most resistant material that can be found, such as manganese bronze, gunmetal, and high chromium content steels.

Naturally corrosion has been one of the major problems of the shipbuilder ever since iron and steel were substituted for wood, but as the author of the contribution points out, serious general corrosion of the hull is now rare because effective protection by painting at regular intervals is carried out. Thus we are informed that in the year 1930, for example, the firm of Blohm and Voss used 200,000 kilos (440,800 lbs. or 196.7 tons) of paint, nearly all Red Lead, while also a good method of protection is galvanising and in this connection also there was utilised 85,000 kilos (187,340 lbs. or 83.6 tons) of zinc.

This is a striking corroboration of the value of red lead paint in protecting iron and steel against corrosion, a fact however that has been known for well over 100 years.

Also modern paint of this character as extensively used not only for shipbuilding and in docks and harbours, but for structural steelwork of every description, including for example, lighthouses, oil tanks, cranes, water tanks, pithead gear, gasholders, and chemical plant of all kinds, is now generally also of the non-setting variety, so that it can be made and supplied in bulk without difficulty. For such paint Red Lead is manufactured by controlling with great accuracy the oxidation of the molten lead with air, first at about 645° F. to the yellowish lead monoxide (PbO) and then at not over 1000° F. to Red Lead (Pb_3O_4) triplumbic tetroxide. In this way non-setting Red Lead, according to the latest British Engineering Standards

Specifications, has a total of over 93 per cent. actual plumbic tetroxide and 90.5 per cent. oxides of lead, that is not more than about 6 per cent. monoxide, excess of which was previously the cause of the trouble of setting with linseed oil, constituting the basis of the paint.

It should be pointed out however that in order to obtain the best results it is necessary to clean thoroughly the steel or iron surface before painting. This is emphasised in the above paper in "Korrosion und Metallschutz" where great stress is also laid on the necessity of removing milled scale from the steel.

On these lines most of the corrosion of iron and steel can be prevented, and there are hundreds of steel structures in Great Britain still in perfect condition to-day after 40-50 years' exposure to sea-water, owing to the efficient use of Red Lead paint. It is, in fact, a curious state of affairs in shipbuilding that corrosion at the present time causes more anxiety in regard to the deterioration of highly resistant metals, such as used for condenser tubes and propellers, than is the case with the must more easily corrodible iron and steel. Also the paper only serves to emphasise that we have still much to learn on the whole subject of the causes of corrosion, particularly for example, the the exact part played by water in motion as against still water. Thus the bronze propellers of high speed vessels are badly affected whereas little trouble occurs with those running at slow speeds, the reason being unknown.

CHEMICALS PURCHASED BY COLUMBIA.

There are no local manufacturers of chemicals in Columbia and the principal sources of supply are the United States, Great Britain, Germany, and Belgium. The most important consumers are soap plants, brewing, sugar, and ice-making establishments. The chief articles of imports are caustic soda, sodium silicate, rosin, sulphur, ammonium carbonate, and boric, acetic, and muriatic acid. The city of Cartagena contemplates the construction of a new aqueduct for the installation of a water purifying plant, which in the future will require water treatment chemicals.

THE MUSLIM ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

At a meeting of the Council of the Muslim Association for the Advancement of Science, held at Aligarh on the 2nd December, 1931, Professor R. F. Hunter in the chair in the absence of the President (H.E. the Nawab Masood Jung Bahadur) who is at present on a special Government Commission appointed by Lord Willingdou, Dr. H. W. Blood Ryan was appointed a Vice-President and Hon. Foreign Secretary for Europe of the Association in recognition of his work for the advancement of international science.

At the same meeting Dr. Blood Ryan was also nominated to a Foundation Research Chair in Physical Chemistry, which among others chairs, is being founded in the New Year.

The scope of the Association is being enlarged from time to time and already it is becoming a scientific force in the Near East and it will become the instrument for linking up all Mohammedan scientists, whether in the Near East, India or Europe. The Vice-Presidents number three, Dr. R. F. Hunter, Dr. H. W. Blood Ryan, and a scientist nominated from Cairo University by the Egyptian Minister of Education.

Professor Hunter is inaugurating the Proceedings of the Association with a lengthy memoir on the results of his investigations (aided by collaborators) in the bromination of heterocyclic compounds of the benzthiazole group. Dr. Blood Ryan will contribute to the literature his researches into the physical properties of refrigerating agents and the microscopy of rare earths. The Association, in conjunction with the Muslim University at Aligarh has delegated to Dr. Hunter the important work of the construction of new laboratories which are now well towards completion.

NEW FRENCH POTASSIUM SULPHATE PLANT.

The Societe Potasse et Engrais Chimiques, formed last year by the Mines Domaniales and the Kali-Sainte-Therese, has recently started production at its plant at Grande Couronne, near Rouen, France. This company will specialise in the production of potassium sulphate on a large scale. First results from the new plant are proving satisfactory.

VALUE OF BRITISH CARBOLIC AND CRESYLIC ACIDS EXPORTS SMALLER 1931.

British exports of carbolic and cresylic acids during the first six months of 1931 show a value decrease :

		Six months			
		1930		1931	
	Unit	Quantity	Value	Quantity	Value
Carbolic acid (crude)	cwt.	15,360	£24,118	24,546	£8,228
Carbolic acid (crystal)	cwt.	6,700	23,182	7,740	19,975
Cresylic acid	gals.	748,179	89,964	513,182	52,824

NEW YORK SECTION, A.C.S.

Dr. Walter S. Landis New Chairman—Membership Now Approximately 2,000.

Dr. Walter S. Landis, vice-president of the American Cyanamid Company, has been elected chairman of the New York Section of the American Chemical Society for 1932, it was announced December 4 at a meeting of the organisation in the Museum of Science and Industry, 220, East Forty-second Street. He succeeds Prof. Arthur E. Hill of New York University.

Dr. Landis, vice-chairman of the Section last year, was a professor in Lehigh University from 1907 until 1912, when he became chief technologist of the American Cyanamid Company. In 1924 he was named vice-president of the company. He is also president of the Fumigators Supply Company, 535 Fifth Avenue, and a past president of the American Institute of Mining and Metallurgical Engineers.

Prof. V. K. LaMer of Columbia University was chosen vice-chairman of the Section and Dr. David P. Morgan, Jun., of Scudder, Stevens and Clark, 111, Broadway, secretary-treasurer.

Dr. J. G. Davidson of the Carbide and Carbon Chemicals Corporation was named to the executive committee, other members of which are : J. D. Detwiler, consulting chemical engineer, the Texas Company; Prof. Arthur E. Hill, New York University; J. M. Weiss, president, Weiss and Downs, Inc.

Councillors were elected as follows : Dr. Landis, Prof. LaMer, Dr. Morgan, Prof. Ross A. Baker, College of the City of New York; F. G. Breyer, chemical engineer, Singmaster and Breyer; B. T. Brooks, consulting chemist; Prof. H. T. Clarke, Columbia University; C. R. De Long, research chemist, Mutuelle Solvay of America, Inc.

Also, Prof. D. D. Jackson, head of the Department of Chemical Engineering, Columbia University; J. V. N. Dorr, president, the Dorr Company; Prof. L. P. Hammett, Columbia University; M. H. Ittner, director of research and chief chemist, Colgate-Palmolive-Peet Company; D. H. Killeffer, manager of the Employment Bureau, the Chemists' Club; H. B. Lowe, vice-president, Chemical Catalogue Company; Leon V. Quigley, technical editor, Bakelite Corporation; Prof. R. R. Renshaw, New York University; S. L. Tyler, The Thermal Syndicate, Ltd.; Lois W. Woodford, assistant to Dr. Charles H. Herty, industrial consultant.

Dr. Oliver Kamm, director of research of Parke, Davis and Company, Detroit, the principal speaker at the meeting, discussed " Chemical Investigations in the Field of the Ductless Glands." The second part of his lecture was devoted to " A Physiological Inquiry into the Mechanism Action of the Water-Retining Hormone."

He differentiated two classes of ductless glands, those which " elaborate and store hormones and those which manufacture them only, with no provison for storage." " The later improvident group," Dr. Kamm continued, " is responsible for the main troubles of the chemist."

Dr. Kamm's own laboratory work has dealt with the pituitary gland, especially with the posterior lobe of this gland, from which he and his assistants were able to isolate two active principles, the alpha and beta hormones, both of which have found important medical applications.

The New York Section, it was announced, now has approximately 2,000 members and is the largest of the Society's eighty sections located throughout the United States. The national membership is about 19,000.

INTERNATIONAL CHEMISTS TO MEET.

NINTH CONGRESS TO BE HELD AT MADRID APRIL 3 TO 10.

The Ninth International Congress of Pure and Applied Chemistry is to be held at Madrid, Spain, from April 3 to 10, 1932, during the same period in which the International Union of Chemistry will assemble in that city.

The general scope of the ninth congress embraces progress of pure chemistry in all its applications and the strengthening of relations between chemists of all nationalities.

The present intention is that the meetings shall be divided into six principal groups, as follows :—

1. Physical and theoretical chemistry.
2. Inorganic chemistry.
3. Organic chemistry.
4. Analytical chemistry.
5. Biological chemistry.
6. Teaching, economics.

SWISS SYNTHETIC ACETIC ACID PLANT IN GERMANY.

The Lonza-Werke Elektrochemische Fabriken of Waldshut, Baden, German subsidiary of a large Swiss concern, has recently opened a new synthetic acetic acid plant not far from the German-Swiss border which is to operate outside of the German synthetic acid syndicate.

Notices of Books.

Practical Microscopy. By L. C. MARTIN, D.Sc., and B. K. JOHNSON, F.R.M.S. Pp. 116. London : Blackie and Son, Ltd. Price 3s. 6d.

This admirable little volume of Blackie's "Technique" series is a very useful addition to the literature on its subject. Essentially, it is intended to enable the reader to apply in practice the technique of modern microscopy and to this end a chapter on ultra-violet microscopy is added. The joint authors are sufficiently authorities on their subject to act as passports to the reader and they have succeeded in their attempt to collate within a minimum number of pages the necessary information to enable one to apply in a practical fashion the technique of modern methods.

Of course, in order for a proper understanding of the use of the microscope to be reached, a knowledge of the optical principles and physical limitations involved is essential, and these are laid down in an easy fashion, thereby enabling the microscopist to utilise his instrument to better effect.

The book is replete with countless diagrams illustrating the text and an interesting feature is the series of actual photographs of instruments, simple and advanced, sold by the leading instrument makers.

Outfits for Absorption Spectrophotometry. Issued December, 1931. Adam Hilger, Ltd., 24, Rochester Place, Camden Road, London, N.W.1.

This booklet is more than a catalogue of instruments; it is a guide to the choice of apparatus for a laboratory. There are undoubtedly many laboratories in which measurements of the absorption curves of substances would assist in the elucidation of problems with which they are concerned, but whose adoption of such methods has been retarded by a lack of guidance as to the most suitable apparatus that can be used. We believe this booklet will materially assist those faced by this problem.

It embraces absorption measurements in the ultra-violet, and in the visible regions of the spectrum. Prominence is given to the first published catalogue description of the Hilger Spekker (Registered trade mark) Ultra-Violet Photometer, a new type of instrument for this work possessing many advantages over the ealier ultra-violet photometers (in whose manufacture this firm were the pioneers). Among the illustrations of this and other apparatus is a full page reproduction of a part of an actual obsorption photograph taken with the ultra-violet apparatus prescribed. In its introductory paragraphs the importance of quantitative absorption spectrophotometry, as opposed to the early method of Hartley, is stressed and some idea is conveyed of the possibilities of these measurements in resolving complex problems of organic chemistry and of biology ,as well as their applications in the control of manufacturing processes.

While there is a note of warning as to the use of photo-electric methods, particulars of

a photo-electric apparatus for absorption spectrophotometry are given.

The booklet terminates with an abridged list of purchasers of such Hilger equipment.

This booklet is supplied post free by Adam Hilger, Ltd., on application.

The Science Masters' Book. Part I. Physics. Part II. Chemistry and Biology. Edited and arranged by G. H. J. ADLAM, M.A., B.Sc. Pp. xvi+256, pp. xvi+267 respectively. London : John Murray. First Edition. Each part 7s. 6d.

These two companion volumes are an admirable (and seemingly necessary) adjunct to a science master's book equipment. The reviewer completed the reading of volume two with the semi-veiled but noticeable sigh—" Oh, but had I a collection of experiments such as these in my student days." Packed into each part are numerous experiments, all of which have been demonstrated by science masters and others in some of our leading public schools and universities—nothing redundant, but an excellent collation of many very necessary illustrations to make easier the study of the subjects passing under review.

Since June, 1919, many of us have looked regularly for our copy of "*The School Science Review*," which is always fairly constant in its presentation of notes on apparatus and experiments and these two volumes appear to be the logical outcome of the aims of *The Science Masters' Association* and the work under review adequately proves its *raison d'être*. Mr. Adlam, ably assisted hy a committee of his association has suceeded in a notable objective, and time will not be wasted if chemists and others removed from the teaching profession, will spare an hour now and then to peruse these pages.

In the reviewer's opinion, *The Science Masters' Book* should become a "*dictionary of experimental ideas*" to the science master and a very useful auxiliary revision book for the earnest student.

The preface apologises for the seemingly "scrappiness" of the work, "lacking continuity, etc," but in a work of this nature it would be physically impossible to coordinate experiments in order of Forms.

The Editor need not have deprecated his efforts, but rather he is to be applauded for such an excellent production.

H.W.B.R.

Forthcoming Events.

FRIDAY, JANUARY 8.

S.C.I. *Glasgow Section.* Eglington Hotel, Ardrossan, at 7.15 p.m. Ardeer and other Societies by invitation. Ardeer Smoking Concert.

SATURDAY, JANUARY 9.

ROYAL INSTITUTION. 21, Albemarle Street, W.1, at 3 p.m. Christmas Lectures. " Light from the Sun and the Stars," by Sir William Bragg, F.R.S.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY. *Chemical Section.* 36, George Street, Manchester, at 7 p.m. Soirée.

MONDAY, JANUARY 11.

INSTITUTE OF METALS. *Scottish Section.* 39, Elmbank Crescent, Glasgow, at 7.30 p.m. " Some Properties of Fire-Bricks," by H. C. Biggs.

INSTITUTION OF ELECTRICAL ENGINEERS. *Western Centre.* Annual Dinner at Cardiff.

TUESDAY, JANUARY 12.

INSTITUTE OF METALS. *North-East Coast Section.* Armstrong College, Newcastle, at 7.30 p.m. " Defects in Non-Ferrous Castings," by R. Dowson, S .G. Homfray, and A. Logan.

INSTITUTE OF METALS. *Birmingham Section.* Chamber of Commerce, Birmingham, at 7 p.m. " Stainless Steel," by J. H. G. Monypenny.

INSTITUTION OF PETROLEUM TECHNOLOGISTS. *General Meeting.* Royal Society of Arts, John Street, Adelphi, W.C.2, at 5.30 p.m.

TUESDAY, JANUARY 12, and WEDNESDAY, JANUARY 13.

FARADAY SOCIETY. University, Oxford. General Discussion on " Adsorption of Gases." General Introduction by Prof. H. S. Taylor. Section I. " Experimental Methods," Introductory Paper by Prof. E. K. Rideal. Section II. " Kinetics and Energetics," Introductory Paper by Prof. H. Freundlich. Section III. " Theories of Adsorption," Introductory Paper hy Prof. M. Polanyi.

WEDNESDAY, JANUARY 13.

S.C.I. *Montreal Section.* Mount Royal Hotel, Montreal, at 8 p.m. " Romance of Insulin and Recent Developments in the Connaught Laboratories," by Dr. J. G. FitzGerald.

THURSDAY, JANUARY 14.

S.C.I. *Yorkshire Section.* Joint meeting with the Leeds Area Section of the Institute of Chemistry. "Recent Developments in the Treatment of Boiler Waters," by Dr. A. W. Chapman. By invitation of the Institution of Mechanical Engineers (Yorkshire Branch).

INSTITUTE OF CHEMISTRY. *Leeds Area Section.* Joint Meeting with the Yorkshire Section of the Society of Chemical Industry. (See above.)

S.C.I. *Nottingham Section.* University, Nottingham, at 7.30 p.m. "Lime and Limestone," by W. Woodhouse.

INSTITUTE OF CHEMISTRY. *Manchester and District Section.* College of Technology, Manchester, at 7 p.m. "Teaching of Applied Chemistry and Facilities for Specialised Post-Graduate Work," by C. H. Creasey.

OIL AND COLOUR CHEMISTS' ASSOCIATION. *London Section.* 30, Russell Square, W.C.1, at 7.30 p.m. "Earth Colours," by W. Armstrong Storey.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by permission of the Controller of H.M. Stationery Office and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., price 1/- weekly (annual subscription, £2 10s.).

Latest Patent Applications.

34,362.—Pratt, D. D.—Production of organic amines. December 11.

Specifications Published.

362,579. — Gesterreichische Chemische Werke Ges.—Process and apparatus for carrying out electrolytic processes more particularly those with decomposable end products, such as for instance, the manufacture of persulphuric acid or of its salts by electrolysis.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

Group Abridgments can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., either sheet by sheet as issued on payment of a subscription of 5s. per Group Volume or in bound volumes, price 2s. each.

356,600.—Purifying lactic acid.—Wulfing, R. Von and Moller, E. (trading as Wulfing J.A.), 231, Friedrichstrasse, both in Berlin.

Lactic acid obtained by fermentation is freed from impurities such as butyric acid, caproic acid and other higher fatty acids by treatment with volatile solvents in which lactic acid is insoluble. Examples of such solvents are carbon disulphide and the chlorinated derivatives of methane and ethane, such as chloroform, ethylene dichloride, and carbon tetrachloride. The solvent, after being shaken with the crude lactic acid in the cold, may be freed from the dissolved impurities by adding a neutralising agent such as lime and separating the insoluble fatty acid salts thus formed. The lactic acid may also be purified by a treatment with the vapour of the solvent in a process analogous to steam distillation, the acid being maintained at a temperature just above the boiling point of the solvent used.

The Latest Trade Marks

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

DICTUM.

526,907.—Chemical substances used in manufactures, photography, or philosophical research, and anticorrosives.—Dictum, Limited, Midland Bank House, 26, Cross Street, Manchester. December 16. (Associated.)

DOUCIL.

526,236.—Chemical substances used for agricultural, horticultural, veterinary, and sanitary purposes. — Joseph Crosfield and Sons, Ltd., Bank Quay, Warrington, Lancashire. December 16. (By Consent.)

THE CHEMICAL NEWS

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NEW YEAR HONOURS FOR WORKERS IN SCIENCE.

The undermentioned appeared in the 1932 New Year Honours List :—

PRIVY COUNCILLOR.

Elliot, Major Walter Elliot, M.C., D.Sc., LL.D., M.B., Ch.B. M.P. for Lanark 1918-23, and for the Kelvingrove Division of Glasgow since 1924. Parliamentary Under-Secretary for Health for Scotland, 1923 to January, 1924, and November, 1924-26. Parliamentary Under-Secretary of State for Scotland, 1926-29. Financial Secretary to the Treasury since August, 1931.

KNIGHTS.

Dale, Henry Hallet, Esq., C.B.E., M.D., F.R.S., F.R.C.P., Director-in-Chief of the National Institute for Medical Research, Hampstead, Secretary of the Royal Society since 1925.

Browne, George Buckston, Esq., F.R.C.S., F.S.A. Purchased the house at Downe, Kent, where Charles Darwin lived, restored and endowed it, and gave it to the British Association in custody for the nation. Has given very generous financial support to medical research work.

Geddes, Patrick, Esq., Emeritus Professor of Botany, St. Andrews University. Lately Bombay Government Professor of Sociology and Civics, University of Bombay. For services to education.

Hammerton, John Alexander, Esq. Editor of the Universal Encyclopædia, Universal History of the World, Peoples of All Nations, etc.

Wellcome, Henry Solomon, Esq., LL.D., F.S.A. Founder of the Wellcome Research Institution. Governing Director of the Wellcome Foundation. Founder of the Wellcome Tropical Research Laboratories, Khartoum. A generous supporter of Medical Research.

K.B.E. (CIVIL DIVISION).

Daniel, Augustus Moore, Esq., M.B., Ch.B. Director of the National Gallery.

Menzies, Frederick Norton Kay, Esq., M.D., F.R.C.P.Ed., D.P.H., F.R.S.E. Chief Medical Officer of the London County Council.

C.B.E. (CIVIL DIVISION).

Chick, Miss Harriette, D.Sc. A distinguished scientific worker in bacteriology and biochemistry. For services to the Medical Research Council in connection with research on vitamins and the science of nutrition. A member of the staff of the Lister Institute.

Menzies, George Kenneth, Esq., Secretary to the Royal Society of Arts.

Mitchell, Lieutenant-Colonel John Malcolm, O.B.E., M.C., Secretary Carnegie United Kingdom Trust.

Mitchell, Reginald Joseph Esq., A.M.I.C.E., F.R.Ae.S., Director and Chief Designer, Supermarine Aviation Works (Vickers), Limited. For services in connection with the Schneider Trophy Contest.

Moore, Harold, Esq., O.B.E., Ph.D., D.Sc., F.I.C., F.Inst.P., Director of Metallurgical Research, War Office.

O.B.E. (CIVIL DIVISION).

Cohen, Captain Bertram Sydney, M.I.E.E., F.Inst.P. Staff Engineer, Research Section, General Post Office.

Houston, Thomas Galway, Esq., F.R.S.A.I., J.P. For 47 years Head Master of Coleraine Academical Institution. A Senator of Queen's University, Belfast.

M.B.E. (CIVIL DIVISION).

Booth, William Newton, Esq., B.Sc., A.M.I.C.E., M.I.Mech.E. Assistant Mechanical Engineer, Royal Ordnance Factories, Woolwich.

Browne, Cecil Tom, Esq. Senior Staff Officer, Patent Office, Board of Trade.

Dale, Walter Wallace Daniel, Esq., M.I.Mech.E., Engineering Assistant to the Director of Dockyards, Admiralty.

D.B.E. (CIVIL DIVISION).

Brown, Miss Edith Mary, L.R.C.P., L.R.C.S.(Ed.), L.R.F.P.S.(Glas.), Principal Women's Hospital and Christian Medical College, Ludhiana, Punjab.

MOTION OF SOLAR PROMINENCES STUDIED.

By N. T. BOBROVNIKOFF.

Assistance Professor of Astrophysics, Ohio Wesleyan University.

During a solar eclipse when the sun is covered by the moon the fortunate spectators can see red flames all around the eclipsed disc. These are called prominences, and their red colour is due to hydrogen gas, one of their chief constituents. The sun has prominences at other times, but their light is so feeble in comparison with the light of the sun itself that we cannot see them under ordinary conditions. However, by means of a spectroscope attached to a telescope, we can see or photograph

them almost any time when the sun is in sight.

The photographs (or as they are technically called, spectroheliograms) taken in the light of only hydrogen or calcium reveal many interesting things about prominences. They can be divided into two groups. Some of them are quiescent, that is, they do not change their shape for days. Others move very rapidly away from the sun, appreciably changing their shape within a few minutes. The latter are called eruptive because of their similarity to the eruption of a volcano.

The spectroheliograms are taken with an instrument called the spectroheliograph. It can be used only when attached to a large telescope, and is rather cumbersome and expensive. The result is that there are only a few spectroheliographs in the world. This is not to the advantage of science, as prominences and other solar phenomena are often of a short duration and can be missed easily by the few astronomers who are in charge of spectroheliographs.

Recently Dr. G. E. Hale of Pasadena, California, invented a new instrument for observing the sun in the light of hydrogen. He has called it the spectrohelioscope. It is used visually and can be set up at any place, not requiring a telescope. Many small observatories and some amateurs have spectrohelioscopes (one is installed at Ohio State University), so that the sun is now under continuous observation. This new instrument has already given us some important information on the motion of prominences.

To obtain an idea of the violence of the forces acting on solar prominences, we may consider the prominence of November 19, 1928, observed at Kodaikanal, India. In some two hours a mass of incandescent gases reached the height of 567,000 miles, which is more than seventy times the diameter of the earth. It began moving with a velocity of 40 miles per second, but at the end of the observation the velocity had increased to 100 miles per second.

In some cases it has been possible to trace the magnetic disturbances on the surface of the earth, and auroras, to such violent disturbances on the sun. The sun presumably ejects charged particles which, after some time reach the earth. The average interval between a solar eruption and magnetic disturbances on the earth is about twenty-six hours. This time is necessary for the charged particles to reach us from the sun.

An attempt to find the laws under which the eruptive prominences move has recently been made by the writer. It was known before that the velocities of eruptive prominences are enormous, sometimes reaching 100 or even 200 miles a second. Furthermore, the velocities increase the farther the prominences go from the sun. By a mathematical analysis of the motion of seventeen prominences a general law could be formed. They appear to move under the pressure of radiation from the sun. The fierce radiation near the surface of the sun drives the atoms of hydrogen and calcium away, like a strong wind driving particles of sand. The analogy is not complete, because in our atmosphere the friction of air soon stops the particles driven by wind, whereas in the extremely rarified atmosphere of the sun there is practically no resistance to the motion of atoms. Wind soon dies down and sand drops down, but on the sun the radiation force on the atoms increases with the velocity which in turn makes them move faster and faster until they are driven out into space. In time they may reach our earth and produce the aurora borealis, or northern lights, or disturb our radio and telegraph communication. Therefore the study of prominences may shed some light on many phenomena occurring in our own atmosphere and on the surface of the earth.

The details of the motion of calcium and hydrogen atoms in prominences bear a remarkable similarity to the motion of gases in comets' tails. It has been generally supposed that radiation pressure drives molecules of carbon monoxide from the heads of comets' into their tails. The present investigation strengthens this hypothesis as it shows that the forces in cometary tails and in prominences are of the same nature, namely light-pressure.

Perkins Observatory,
Delaware, Ohio.

NEW SODIUM SULPHATE PLANT IN CANADA.

The contruction of a new sodium sulphate plant is contemplated by a Canadian firm. The site of the sodium sulphate deposits parallels the Canadian National Railway's tracks for a distance of 12 miles between Oban and Landis. When completed this plant will the the fifth in the Province of Saskatchewan.

AN EXPANDING AND THEN CONTRACTING UNIVERSE FOLLOWED BY ANOTHER EXPANSION AND CONTRACTION, SO ON *AD INFINITUM.*

By F. H. Loring.

Professor R. C. Tolman in the *Physical Review* of August 15th, 1931, pages 797 to 814, brought his views of the universe to an issue, whereby he postulated the running-up, so to speak, of the universe thermodynamically, based on the observational phenomenon that the most distant nebulæ were all receding from us at the enormous speed of about 12,000 miles a second, thus obviating the difficulty of the increasing entropy of the universe as a whole. This phase of the subject was outlined by the present writer in the *Chemical News* of October 16, 1931, pages 246 to 247. A minor correction appeared on page 275.

In the *Physical Review* of November 1, 1931, pages 1758 to 1771, Professor Tolman carries his argument further, using as before mechanics and thermodynamics as conditioned, or super-conditioned, by the principle of relativity. Here he investigates the requirements of a nonstatic universe to exhibit a behaviour which is periodic in time, as indicated by the title of this article.

In this article, under review here, the universe would be considered as filled with fluid in uniform distribution with (according to relativity) the time co-ordinate chosen to agree with the proper time as used by local observers at rest in the said fluid.

Professor Tolman says :—" It is first shown that the analytical requirements which would correspond to the continuous expansion and contraction of such models between definite maximum and minimum limits, together with the thermodynamic requirement that the expansion and contraction must be reversible, could not both be simultaneously satisfied with any fluid for filling the model which has reasonable properties."

Attention is then directed to models of the universe having line elements which would be quasi-periodic in time, this leading to a wide range of possibilities in models expanding from zero proper volume to a maximum and then contracting; but the treatment fails to provide the analytical conditions for a minimum at the lower limit.

Nevertheless, from a physical view, contraction to zero proper volume could only be followed by renewed expansion, so that a series of expansions and contractions might be expected to take place.

It is found possible to satisfy these requirements for such quasi-periodic behaviour by models which would expand and contract at a finite rate reversibly without increase of entropy, so that a continued series of identical expansions and contractions would be expected.

Einstein (*Berlin Ber.*, 1931, p. 235) proposed a nonstatic model universe filled with incoherent matter, exerting no pressure and unaccompanied by radiation which would satisfy the thermodynamic as well as the analytical requirements for the above series of repetitions; and models, filled solely with black-body radiation with an equilibrium mixture of radiation and perfect gas, are discussed, which also satisfy these requirements.

It is to be noted in particular that the expansion and contraction of the Einstein model would not involve an increase of entropy and therefore it could be perpetually periodic.

Professor Tolman's concluding remarks (given in part here) bearing on such findings as outlined above are :—". . . . . Finally, it has been shown in accordance with the principles of relativistic thermodynamics that the conditions necessary for such quasi-periodic solutions could be met by systems which expand and contract reversibly without increase in entropy, so that there would be no thermodynamic hindrance to a continued series of identical expansions and contractions, and this conclusion has been illustrated by three examples," these being :—(1) The incoherent matter one, (2) the one filled solely with black-body radiation, and (3) one filled with a mixture of perfect monatomic gas in equilibrium with black-body radiation (see previous article in the *Chemical News* cited above). Professor Tolman here refers to specific features to be considered which make the problem uncertain, but " nevertheless, the principles

of relativistic thermodynamics seem to have made a real contribution to cosmology, in showing that reversible models can at least be conceived which could exhibit a succession of identical expansions and contractions taking place at a finite rate."

The present writer has drawn freely from the language of Professor Tolman in giving this sketch without touching upon the mathematical part of the paper which could only be properly appreciated by those versed in the subject and by consulting the original.

Matters of the above kind may seem to be infinitely removed from all practical politics, but intellectually new dishes are demanded; and one never knows but that a fundamental law may be discovered in some such way, and this law may be of far reaching significance. It is probable that Professor Tolman has made such a contribution to science.

2nd December, 1931.

The Eradication of Weeds by Chemicals

By R. M. WOODMAN AND W. A. JONES.

Some heavy, ill-drained, gault land, beonging to Trinity College, Cambridge, and situated adjacent to the University Farm, Cambridge, was found in 1931 to be infested with noxious weeds following the removal of a poor crop of wheat in September, 1930. It was resolved to try the effect of chemicals (particularly chlorates) on the weeds, and, for this purpose, an area was selected where the following weeds were abundant: *Allium vineale* (wild onion), *Rubus caesius* (dewberry), *Cnicus arvensis* (creeping thistle), *Ranunculus repens* (creeping buttercup), *Linaria spuria* (male fluellen), *Taraxacum officinale* (dandelion), *Plantago* (plantain) and *Geranium molle* (Dove's-foot crane's-bill); *Trifolium pratense* (red clover), *Agrostis* spp. (bent) and *Alopecurus agrestis* (black grass) were also present to a lesser extent.

The experiments consisted in spraying 1/160th. acre square plots with 5 and 15 per cent. solutions of sodium chlorate, calcium chlorate, calcium chloride and zinc sulphate; the solutions were sprayed at the rate of 1 gallon to each plot by means of a watering-can with a coarse rose. The arrangement of the plots was in two groups, each group consisting of a 1/160th. acre control plot entirely surrounded by eight adjacent treated plots.

Eight plots were treated with 5 and 15 per cent. solutions of the four chemicals respectively on March 14th 1931; the remaining eight treated plots received similar treatment on June 4th, 1931. The plots were inspected on the following dates: 23/3/31, 18/5/31, 1/6/31, 24/7/31, 27/9/31. Brief notes follow as to the appearance of the treated as compared with the control plots, on which the weeds were thriving at each inspection.

Plots sprayed with 5 or 15 per cent. zinc sulphate 14/3/31 *or* 4/6/31: At no subsequent inspections did the plots materially differ from the controls; zinc sulphate is not a weed killer.

Plots sprayed with 5 or 15 per cent. calcium chloride, 14/3/31 *or* 4/6/31: Similar remark; calcium chloride is not a weed killer.

Plots sprayed with 5 or 15 per cent. sodium chlorate, 14/3/31: (*a*) *5 per cent.*: 23/3/31: harmful effect on most weeds; wild onion affected very little except possibly some plants arising from bulbules. 18/5/31: had killed many plants of most species; onions not affected; dewberries sprouting from crown, though the aerial parts had been destroyed; some clovers and dandelions still alive. 1/6/31: surviving plants recuperating and growing healthily, but less in number than on control plots. The onions from bulbs had survived and were beginning to form bulbules. (*b*) *15 per cent.*: 23/3/31: very pronounced effect; all plants excepting onion seriously affected (seedling onions from bulbules were greatly affected). 18/5/31: plot almost bare except for onions from bulbs; a few sickly, yellow-leaved dandelions still survived; the runners of the dewberry were definitely killed, but a few shoots were observed arising from the underground parts. 1/6/31: onions from bulbs had survived; other surviving weeds were recuperating.

Plots sprayed with 5 or 15 per cent. sodium chlorate, 4/6/31 : (*a*) *5 per cent.* : 24/7/31 : probably slightly more effective than the earlier application, onions from bulbs not affected. 27/9/31 : plot still bare except for onions from bulbs, a few dewberries, dandelions, male fluellen, creeping buttercups and clovers. (*b*) *15 per cent.* : 24/7/31 : Almost bare but for onions. 27/9/31 : completely bare but for onions.

Plots sprayed with 5 or 15 per cent. calcium chlorate, 14/8/31 *or* 4/6/31 : Similar remarks apply as for sodium chlorate, except that the calcium salt is not quite so effective against dewberry.

These preliminary experiments tended at the outset to show that the chlorates were efficient weed killers, as has been demonstrated by various experimenters.* The wild onion, however, was not seriously affected by the chlorates.† It was thought that non-wetting of the onion surfaces by the chlorate solutions might have been responsible for the poor effect, and the following experiments were designed with the notion of comparing the weed killing effect of wetting[1] solutions of chlorates with other possible weed killing media. The following were tried :

(1) *Cresols-soap solution* : Made as detailed previously;[2] 400 gm. of soft soap and 400 cc. of cresylic acid were triturated together to give a clear solution. This was used at 5 and 10 per cent. solution by volume in water.

(2) *Phenol-soap solution* : Liquefied phenol was substituted for cresylic acid in the above.[2]. Solutions of the same concentration were used.

(3) *Paraffin emulsion from a miscible oil* :[2, 3] 400 cc. of no. 1 above were mixed with 400 cc. of paraffin (lighting) oil to give a clear solution. This solution was a miscible oil, yielding oil-in-water emulsions on pouring into water and stirring. The emulsions used contained 5 and 10 per cent. miscible oil by volume.

(4) *Coal tar creosote emulsions from a miscible oil* :[2, 3] Made in the same manner, coal tar creosote being substituted for paraffin oil. The emulsions used contained 5 and 10 per cent. by volume of the miscible oil, though the oil-in water emulsions formed on pouring into water were not quite perfect (the presence of free oil, however, is probably an aid to weed killing).[4]

(5) *Carbokrimp* : 5 and 10 per cent. emulsions of this proprietary miscible oil were used.

With the five media detailed, no spreader[1] was needed because sufficient soap was present to confer wetting and spreading properties. The dike water used in diluting these media, and in making subsequent spraying media containing soap as a spreader, was, however, treated by the addition of sufficient 10 per cent. soap solution to cause complete softening. Thus the " incompatibility " of the soap and the hard ditch water was avoided.[5]

(6) *Sodium arsenite* : Solutions of this were used at the following concentrations :

(*a*) 5 per cent. solution on uncut weeds without a spreader.
(*b*) 5 per cent. solution on cut weeds without a spreader.
(*c*) 2 per cent, solution on uncut weeds; solution also 1 per cent. as regards soap.
(*d*) 2 per cent. solution on cut weeds; solution also 1 per cent. as regards soap.
(*e*) 5 per cent. solution on cut weeds; solution also 1 per cent. as regards soap.
(*f*) 5 per cent. solution on cut weeds; solution also 1 per cent. as regards soap.

Close cutting of the weeds previous to application of the spray should tend to level up any superiority conferred by a spreader, as the spray should cause death by way of the wounds, without spreading over the whole of the weed surfaces being necessary.

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* *c.f.*, Army, Bridgford and Dunham : Univ. of Minnesota Agric. Extension Divn. Circ. No. 82 (1930); the fire and explosion hazards of chlorates are also discussed here.

† At the Herts. Institute of Agriculture, Oaklands, spraying a field of wild onions (which had been cut with a mower) with sodium chlorate was found " the most effective treatment for its destruction." The sodium chlorate was most efficient when sifted and applied as a dust. (Private communication 20/10/31).

(7) *Arsenic pentoxide*: A 5 per cent. solution was used on cut and uncut weeds. A solution of arsenic pentoxide (*i.e.*, really an arsenic acid solution) is used in the preparation of a weed killer against prickly pear in Australia.[4]

(8) *Sodium chlorate*: 5 and 10 per cent. solutions at the same time 1 per cent. as regards soft soap were used. Some of the soap was precipitated (salted out) by the chlorate, the case being one similar to the so-called pseudo-hardness of water due to sodium chloride.[3]

(9) *Calcium chlorate*: 5 and 10 per cent. solutions containing calcium caseinate (present in such proportion that the spray was 0.5 per cent. as regards casein itself) as wetter and spreader. The caseinate was made according to a formula given previously,[1] 22.5 gm. of casein and 5.94 gm. of calcium oxide being present per gallon of spray. Soap would have been impossible as a wetter and spreader because of incompatibility[5] with the calcium chlorate; a non-wetting calcium soap would have been precipitated.

(10) *Sulphuric acid*: Solutions have been recommended as practical weed killers;[6] 2½ per cent. solutions were tried on cut and uncut weeds.

(11) *Sodium thiosulphate*: 5 and 10 per cent. solutions at the same time 1 per cent. as regards soap were used.

Two control plots were left, one cut and one uncut, making a total of 28 plots. The 26 treated plots were randomised round the two controls, the arrangement being such as to occupy a rectangle 7 plots long by 4 plots wide. Interference pathways (the weeds on these being close cut) were left between the plots.

The plots were square and 1/160th acre in area. In the centre of each was permanently marked out by posts and wires a small area 1ft. 9ins. square (i.e., about 3 square feet.). On May 25th, 1931, the plants occurring on these small squares were identified and recorded. Some days after treatment, identifications and counts of plants were again made. The squares were taken to represent a moderately-accurate representation of the whole plot.

The sprays were applied between 8 a.m. and 2.30 p.m. on May 29th, 1931. The weather was fine when spraying commenced, but there was not bright sunshine. An easterly wind arose later, and, at 8 p.m. heavy rain fell for 30 minutes. Approximately one gallon of spray was used per plot, the spraying apparatus being a 2½ gallon "Four Oaks" knapsack sprayer with a double medium nozzle, loaded with 1 gallon of spray at a time. The residue in the sprayer was about 150 cc., so that the actual volume of spray per plot was approximately 1 gallon less this amount. Close cutting by hand shears of the necessary plots was done just previous to application of the spray; the cut material was raked off.

A key to the plots, together with certain details* as regards number of weeds on the sample plots, is given in Table I. In this table, "a" and "f" represent abundant and few seedlings (mainly *Senecio*) on the sample squares, respectively; a bar (—) represents full kill of the weed; and a query denotes inability to count on a cut plot.

A list of the weeds indentified and counted* on the sample plots follows; weeds marked with an asterisk were counted as "shoots":—

(1) *Allium vineale* (wild onion); (*a*) from bulbs; (*b*) from bulbules. (2) *Cnicus arvensis* (creeping thistle). (3) *Sonchus* spp. (sow thistle). (4) *Avena fatua* (wild oat). (5) *Convolvulus arvensis* (bindweed).* (6) *Rubus caesius* (dewberry).* (7) *Alopecurus agrestis* (black grass). (8) *Brassica sinapis* (charlock). (9) *Euphorbia* spp. (spurge). (10) *Ranunculus repens* (creeping buttercup). (11) *Trifolium pratense* (red clover). (12) *Triticum* (wheat). (13) *Medicago lupulina* (medick). (14) *Geranium molle* (Dove's-foot crane's-bill). (15) *Geranium dissectum* (cut-leaved crane's-bill). (16) *Daucus carota* (wild carrot). (17) *Agropyrum repens* (couch grass). (18) *Bellis perennis* (daisy). (19) *Potentilla reptans* (cinquefoil). (20) *Senecio vulgaris* (groundsel). (21) *Linaria spuria* (male fluellen). (22) *Taraxacum officinale* (dandelion). (23) *Plantago lanceolata* (narrow-leaved plantain). (24) *Anagallis arvensis* (scarlet pimpernel). (25) *Prunella vulgaris* (self-heal). (26) *Aegopodium podograria* (goutweed). (27) *Galium aparine* (cleavers). (28) *Agrostis* (bent). (29) Seedlings (mainly *Senecio*).

* Full details of counts of individual weeds are omitted in order to save space.

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Reference no. of Plot	Weed killing medium.	Concentration	Treatment of plot	Total befo
1	Cresols-soap soln.	5 per cent. by vol.	uncut	
2	Ditto	10 ,, ,, ,,	,,	
3	Phenol-soap soln.	5 ,, ,, ,,	,,	
4	Ditto	10 ,, ,, ,,	,,	
5	Na arsenite soln. No spreader	5 per cent. by wt.	,,	
6	Paraffin oil emulsion...	5 per cent. by vol.	,,	
7	Ditto	10 ,, ,, ,,	,,	
8	Na arsenite soln. No spreader	5 per cent. by wt.	cut	
9	Ditto ... ... With spreader	5 ,, ,, ,,	uncut	
10	Ditto Ditto	2 ,, ,, ,,	,,	
11	Ditto Ditto	2 ,, ,, ,,	cut	
12	Ditto Ditto	5 ,, ,, ,,	,,	
13	Sulphuric acid soln.	2½ ,, ,, ,,	uncut	
14	1st control plot	——	,,	
15	2nd ditto	——	cut	
16	Sulphuric acid soln.	2½ per cent. by wt.	,,	
17	Arsenic pentoxide soln.	5 ,, ,, ,,	uncut	
18	Ditto	5 ,, ,, ,,	cut	
19	Carbokrimp emulsion	10 per cent. by vol.	uncut	
20	Ditto	5 ,, ,, ,,	,,	
21	Na chlorate soln. With spreader	5 per cent. by wt.	,,	
22	Ditto Ditto	10 ,, ,, ,,	,,	
23	Ca chlorate soln. ... ...Ditto	5 ,, ,, ,,	,,	
24	Ditto Ditto	10 ,, ,, ,,	,,	
25	Coal tar creosote emulsion	5 per cent. by vol.	,,	
26	Ditto	10 ,, ,, ,,	,,	
27	Na thiosulphate soln. With spreader	5 per cent. by wt.	,,	
28	Ditto Ditto	10 ,, ,, ,,	,,	

l no. of weeds ter spraying (12/6/31)	Percentage reduction in total no. of weeds	No. of wild onions before spraying (25/5/21)	No of wild onions after spraying (12/6/31)	Percentage reduction in no. of wild onions
47(f)	70	37(103)	25(7)	33(93)
42(f)	72	32(95)	20(12)	38(87)
43(f)	51	14(43)	12(17)	14(60)
61(a)	48	62(23)	36(9)	42(61)
4(—)	96	38(51)	4(—)	90(100)
50(f)	63	23(66)	8(5)	65(92)
11(f)	81	2(31)	1(3)	50(90)
2 ?(f)	97 ?	10(13)	?(?)	?(?)
2(—)	95	9(9)	2(—)	78(100)
10(—)	91	14(66)	4(—)	71(100)
3 ?(—)	99 ?	4(236)	?(?)	?(?)
5 ?(—)	96 ?	48(51)	2(?)	96(?)
237(f)	5	5(223)	5(205)	0(8)
109(a)	8	19(68)	19(61)	0(10)
?(a)	?	29(87)	?(?)	?(?)
3 ?(a)	97 ?	5(55)	?(?)	?(?)
5(—)	93	5(89)	—(—)	100(100)
?(—)	?	26(158)	?(?)	?(?)
41(f)	73	22(105)	14(11)	36(90)
44(f)	25	24(7)	17(—)	29(100)
20(—)	81	35(46)	18(—)	49(100)
6(—)	97	6(142)	6(—)	0(100)
24(—)	78	25(46)	23(—)	8(100)
25(—)	74	21(49)	21(—)	0(100)
50(—)	42	40(32)	31(12)	23(63)
39(—)	78	13(135)	10(24)	23(82)
62(a)	36	14(56)	14(24)	0(57)
92(a)	30	21(68)	21(29)	0(57)

In Table I the reduction in the total weeds brought about by the application of the spray is given; as wild onions were predominant on practically every plot, detailed figures are given for these also, particularly as the wild onion is difficultly-eradicable. The reductions are given as percentages of the number of weeds present before spraying; the information in parentheses in columns 5 and 6 refers to eradication of seedlings; the numbers in parentheses in columns 8, 9 and 10 refer to wild onions arising from bulbules, as it is important to distinguish these onions from the more difficultly-eradicable onions arising from bulbs. As a rough guide to the efficacy of any treatment, the weed killers can be arranged in classes according as the reduction in weeds falls within the following tentative and arbitrary limits: <33 per cent. reduction, no weed killing effect; 33-66 per cent. reduction, moderate weed killers; 66-90 per cent. reduction, good weed killers; >90 per cent. reduction, excellent weed killers.

In general it will be noticed that, where the plots were cut, quantitative data could not be obtained; it is reasonable to assume, however, that if a weed killer were successful on an uncut plot, it would be still more efficient on the cut plot.

The chlorates are good or excellent weed killers for general weeds, seedlings and onions arising from bulbules (on or near the soil surface); they are not very effective against onions arising from bulbs (below the soil surface), however. Thus, though chlorates, from the length of time usually elapsing between application and visible weed killing effect, seem to act through the soil, the onion bulbs must be normally too deep to be greatly affected.

Sodium arsenite is an excellent general weed killer at 2 or 5 per cent. concentrations, with or without a spreader; thus on six plots the percentage kill is greater than 90. It is also excellent against onions from bulbules, and good against onions from bulbs. Similar remarks apply to the arsenic pentoxide solution, and it would seem that these arsenic compounds act both by direct contact with the plant and possibly to some extent through the soil.

If arsenic and other inorganic compounds can act to some extent through the soil, two points need attention drawn to them: in the first place, it must be remembered that such compounds should only be used during a fallow, and that the time elapsing before safe sowing is possible should be ascertained by actual trial before serious recommendation; secondly, it should be noticed that only compounds with toxic anionic elements or groupings could thus be toxic when applied to the soil in limited amounts, as the toxic metallic cation of any soluble inorganic weed killer (*e.g.*, copper sulphate) would be "fixed" in the soil by base exchange, and would be inoperative unless its hydroxide were soluble, and thus capable of formation by hydrolysis of the clay or humate present as a result of the base exchange.* A toxic anion such as exists in sodium arsenite or arsenate cannot be so "fixed" chemically in the structure of the soil. The compound may give by base exchange, or by action on hydrogen clay, an insoluble or soluble salt of another base, or a soluble acid or oxide (*e.g.*, arsenic acid); if the resulting product were soluble, it would, presumably, be phytocidal and also capable of being washed from the soil.

Of the remaining weed killers, the following deserve mention: cresols-soap solution and coal tar creosote emulsion (10 per cent.) for onions from bulbules, and paraffin oil emulsion as a moderately good general phytocidal agent. In connection with the last-named, it is worthy of note that so long ago as 1914 paraffin oil[7] itself was recommended as a mist spray at 75 gall p.a. on a fallow for eradicating wild onion, apparently with some reason.

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Summary.

Of a large number of weed killers examined as general weed killers and as specific weed killers against wild onion, sodium arsenite, arsenic acid solution and chlorates are demonstrated to be the best. Onions arising from bulbs are much harder to kill than those arising from bulbules, and, in this connection, arsenic compounds are

* This limits possibilities of efficient toxic action via the soil by metallic salts to the alkali and alkali earth groups unless the anionic grouping is also toxic.

much more efficient than chlorates. Spreaders are used with weed killers for the first time.

REFERENCES.

1 Woodman : *J.S.C.I.*, 1930, *49*, 93T.

2 Woodman : *J. Pomol. Hort. Sci.*, 1925, *5*, 48; *Chem. News*, 1926, *133*, 339; 356; *J. Agric. Sci.*, 1927, *17*, 44.

3 Woodman : *J. Pomol. Hort. Sci.*, 1928, *6*, 318.

4 Woodman, *J.S.C.I.*, 1930, *49*, 193T.; Woodman and Wiley : *ibid.*, 1931, *50*, 187T.

5 Woodman : *N.F.U. Year Book*, 1931, 401.

6 Brown and Streets : *Univ. of Arizona Agric. Expt. Stn.* Bull No. 128 (1928).

7 Pipal : *Indiana Stn. Bull.* No. 176 (1914).

Horticultural Research Station,
School of Agriculture,
Cambridge University.

THE HEATING VALUE OF EXHAUST STEAM.

A Notable Point for Chemical Works Practice.

By A Well Known Engineer.

For all industries using a large amount of heating and process steam the ideal method, which applies particularly to chemical works, is to operate with high speed back-pressure steam engines or turbines direct coupled to electrical generators. Power for the latter is obtained by the drop in the steam pressure without condensation, providing electricity in the cheapest possible manner, while all the exhaust steam, at any desired pressure, say with the range of 1-25 lbs. per sq. inch, is used for boiling, heating and general process work.

This method is far more economical than purchasing electricity from a power station, or using condensing engines or turbines and providing steam for heating direct by means of low pressure boilers, for the simple reason that with condensing sets all the exhaust steam is wasted, resulting in an over-all thermal efficiency of only about 15-22 per cent. from the raw coal to the switchboard. Even the smallest back-pressure plant, however, will give much better results, with 60 per cent. thermal efficiency or over, because all the exhaust steam is usefully employed instead of being thrown away in the cooling water. A curious fact also, of great interest to chemical engineering, is that exhaust steam from engines or turbines at, say, 3-25 lbs pressure has better heating properties than live steam at 3-25 lbs. pressure taken direct from a low pressure boiler plant or through a reducing value. There is no question as to the accuracy of this statement, whatever may be the explanation, and for example in many cases with "Belliss and Morcom" back-pressure sets, both engines and turbines, it has been found that the installation, using a high steam pressure, has not resulted in any increase in the coal consumption now providing the same amount of heating steam as before with all the power in addition. In fact, in many cases the coal bill is reduced slightly.

Thus in a celluloid works when a gas engine and a 150 h.p. Diesel engine was shut down and all the power provided by a "Belliss" back-pressure set, with steam exhausting at 5 lbs. per sq. in., decidedly less coal than before was used. A number of dyeing, calico-printing, and bleaching works report the same experience, and one dye-works for example finds a reduced amount of coal is required when running the back-pressure engine sets and generating all the power than when using the boilers for process work alone, and purchasing all the electricity. Also in several cases it has been proved that the exhaust steam from the engines gives quicker dyeing than live steam of the same pressure.

Again in a block of flats a very small 25 kw. "Belliss" back-pressure lighting set is saving £1,200 per annum, the sum formerly paid to the Corporation for electric lighting, while no increase in the coal bill has been noticed, with the same hot water supply as before. Also a firm of heating engineers find that exhaust steam at 2 lbs. pressure with a vacuum pump gives as good a result in a long steam heating circuit as steam supplied direct from boilers at 15 lbs. pressure. There are many other similar cases, and probably the explanation is that exhaust steam from an engine or turbine is completely and uniformly saturated and therefore transmits the heat quicker to the pipes and other metal surfaces as compared with steam not previously expanded to produce work, or passed through a reducing valve where the nature of the expansion is somewhat different.

ANNUAL MEETING OF THE SCIENCE MASTERS' ASSOCIATION.

THE BEARING OF ORGANIC CHEMISTRY ON GOOD HEALTH AND LONGEVITY.

The members of the Science Masters' Association were in conference on 30th December, 1931, at the Imperial College of Science, South Kensington, and Professor J. Field Thorpe, F.R.S., Professor of Organic Chemistry at the College gave a highly illuminating address on the new vista organic chemistry is opening up for mankind.

He said that on the biochemical side organic chemistry presented great possibilities of future development which would have been regarded as incredible 25 years ago. Already it had become evident that the processes of life were controlled by the presence of definite organic compounds. Some of these were produced in the body; others were introduced into the body through the food we ate, but all were essential to health and life. Indeed it could be prophesied, said Professor Thorpe, that sometime in the future ill-health and disease would be eliminated by the readjustment of the impaired bodily function through the administration of the required organic substance in the correct quantity. Here then (he continued) was a field of research the vastness of which staggered the imagination, because each substance would have to be isolated and its constitution determined, and it would then have to be synthesised. The substances of this type already recognised were firstly the hormones which were secreted by the glands and employed to fulfil their functions as the body required them. The most important of these were adrenaline, the active principle of the suprarenal gland; insuline obtained from the pancreas; and thryoxine, the principle of the thyroid gland. These compounds were definite organic substances, all of which exercised some special purpose in the body.

The second type of organic compound which had been found to be essential to the performance of certain bodily functions were, Professor Thorpe said, the vitamins, and the work done on these substances during the past few years showed that, like the hormones, they were definite organic substances. There was reason to suppose that in the near future their constitutions would be determined, and when this was done their synthetic preparation would undoubtedly follow. It was necessary to consider only Vitamin D and Vitamin A as being typical of this class, although it was stated that Vitamin E, the anti-scorbutic vitamin, had just recently been isolated from orange juice. Calciferol (Vitamin D) had been isolated as the result of work spread over the past 12 years. In 1919-20 it came to be recognised that rickets, due to defective deposition of calcium phosphate in the bones, could be cured by exposing the patient to sunlight and also by administering cod-liver oil. In addition, the disease was prevented provided a sufficient amount of summer butter was included in the diet. Cod-liver oil was about 50 times as active as butter in its antirachitic action. This Vitamin D activity was later traced to the unsaponifiable fraction of cod-liver oil, thence to the sterol content of the unsaponifiable fraction. It was then found that cholesterol, seemingly pure, when submitted to ultra-violet irradiation became powerfully antirachitic. Vitamin A was normally stored in the liver, and the livers of animals deprived of Vitamin A and carotene soon became depleted of it. Carotene (the colouring matter of the carrot) was the precursor in the animal body of Vitamin A, the carotene of herbage being converted into Vitamin A in the animal and stored in the liver. The livers of animals fed on carotene became rich in Vitamin A. A lack of Vitamin A rendered animals very subject to infection, and the mucous surfaces appeared to lose their power of resisting the attacks of organisms.

Dr. G. C. Simpson, director of the Meteorological Office, gave an address on "Modern Weather Forecasting." Before the War, he said, weather forecasting was carried out largely by rule of thumb methods. Since the War very intense investigations of the detailed structure of the atmosphere both at ground level and in the upper atmosphere had been carried out in most parts of the world. In consequence the meteorologist now knew much more about why things happened and was therefore in a much stronger position to anticipate future weather.

THE AMERICAN INSTITUTE OF PHYSICS.

To meet a generally recognised need for an agency suitably constituted to undertake co-operative projects, the American Physical Society, the Optical Society of America, the Acoustical Society of America and the Society of Rheology have formed the American Institute of Physics. This new organisation is controlled by the four societies, and certain specific tasks have been outlined for its first efforts. It does not have individual memberships at the present time, and its constitution is still in process of development. The headquarters office of the institute is at 564, Madison Avenue, New York, N.Y.

Three major tasks have been set for the immediate attention of the institute. The first and most pressing is concerned with the journals of the four societies, which include *The Physical Review*, *Reviews of Modern Physics*, *Physics*, the *Journal of the Optical Society*, the *Review of Scientific Instruments*, the *Journal of the Acoustical Society*, and the *Journal of Rheology*. With perhaps one exception these journals are projects which the societies find increasingly difficult to support. And yet they are vitally necessary publications. This situation was brought to the attention of the Chemical Foundation, whose financial assistance in publications of a scientific character is well known. In conference it was recommended that a co-operative organisation representative, so far as possible, of all physics should be formed at once, and the material help of the Chemical Foundation in such a project was promised.

U.S. COMMENCES BIGGEST RESEARCH SCHEME IN HISTORY.

Under the control of the Surgeon-General of the United States, the greatest research ever undertaken into cancer, 'flu, pneumonia, infantile paralysis, heart disease and common colds, is being started by the American Government.

The proposal is to create what may aptly be termed " a clearing house of health," which will be controlled and conducted by an army of internationally famous experts. The new National Institute of Health at Washington is the administering body and functions as the scientific research department of the U.S. Public Health Service, being in itself controlled by an " executive director."

The executive director says : " This institution will carry on new researches on a greater scale than ever before attempted. We shall marshall the nation's experts in medicine, surgery, psychiatry, dentistry, physics, chemistry, biology, radiology, bacteriology, pharmacology, pharmacy and allied professions.

Notices of Books.

Chemischer Handatlas: Anorganische Chemie unter besonderer Berücksichtigung von Atomphysik und Atomchemie. Von W. WALTER MEISSNER. 60 vielfarbige, vollseitige Karten, fünfsprachig beschriftet (deutsch, englisch, französisch, italienisch, spanish). 64 kartenbeschreibende Textseiten, 24 Seiten: Vorwort, Literaturregister, Namen- und Stichwörterverzeichnis für Karten und Text, Kartenverzeichnis, Inhaltsübersicht. Format: 26 x 23 cm. (Weltatlasformat). Dauerhaft in Ganzleinen geb. M. 38. Georg Westermann, Braunschweig, & Berlin W 10, & Hamburg. 1931.

This book (text in German except for leading titles as below) is a mine of information, the presentation of data being largely graphic (aided by colour). The periodic table is reproduced 58 times, each time containing data so set out thereon as to enable one to see at a glance the changes that take place in passing from element to element. The colour scheme is most elaborate, there being as many as 6 or 7 colours on some tabular classifications. In addition to colours, various symbols and lines (ordinates) are used. The following data are treated in this manner :—

Periodic system of elements, short-period form; atomic weights.

Periodic system of elements, long-period form : densities.

Metals — Amphides — Metalloids — Inertides : characterising compounds.

Distribution of valency electrons and *fundamental terms* : atomic and specific heats.

Distribution of multiplet structure : Optical scheme.

Cosmic occurrence of the elements : meteorites, sun, stars and " lanthaniden (57-71)."

Geochemical distribution of the elements : biosphere, atmosphere, lithosphere, chalkosphere and siderosphere.

Occurrence of the elements in the whole earth.

Magnetic-paramagnetic distribution of the elements.

Sedimentary-paramagnetic distribution of of the elements.

Occurrence of the elements in the crust of the earth.

World map giving positions of ore deposits.

History of the preparation of the elements : discoveries : names.

Methods for the preparation of pure elements.

Isotopes (up-to-date here as elsewhere).

Packing effects (curve method not given).

Energy of emission of H-rays. Kirsch and Patterson's results included with those of Rutherford and others.

Electronic shells of the neutral atoms (6-colour scheme).

Atomic volumes : The curves show great regularity.

Atomic diameters : The curves show great regularity.

Atomic frequencies of the elements : Carbon has the highest value.

Electronic shells of the ions (6-colour scheme again).

Condition of the external electronic shells in the case of ions.

Ionic radii (I). Work of three chief investigators shown.

Ionic radii (II). Values plotted in Angström units as above.

Ionisation potentials I and II (pp. 26-27).

Electrical conductivities : Cu is given as the best, being evidently the single crystal value, otherwise Ag would lead.

Normal potentials of the elements.

Magnetic susceptibility of the elements.

Hardness and coefficient of cubic expansion.

Cubic compressibility and coefficients of linear thermal expansion.

Melting-points and heats of fusion of the elements.

Boiling-points and molecular heats of evaporation of the elements.

Hydrogen-valency of the elements.

Oxygen-valency of the elements.

Halogen-valency of the elements.

Polymorphism (modifications) of the elements.

Groups of properties of the elements.

Heats of formation (combustion) of the elements.

Dipole-moments (dipole-lengths) of the elements.

Crystal structures of the elements.

Crystal combinations A.

Relation between formation of mixed crystals and ionic size.

Co-ordination numbers *and complex* compounds.

Hydrides, chlorides, oxides, carbides, sulphides, nitrides, hydroxides, etc., expressed on 12 periodic tables.

Behaviour of the most important metals towards group reagents.

Behaviour of anions and cations in the systematic separation process.

Group of properties of compounds.

As an example in the use of symbols and colours (mentioned above) in this last tabular classification, Mn has a blue diamond with one axis vertical, a half-diamond in red, a blue square, a black hexagon, a black diamond (parallelogram) with long axis inclined from the horizontal, three curly lines, a round blue spot, a black ring, and the periodic square is coloured mauve, using in some cases approximate terms.

Opposite to each chart-page, as outlined above, is the ordinary page which is filled with closely-set matter in small type, and here and there are tables and formulæ and references are given. The work is very fully indexed.

All the periodic tables are profusely coloured.

This book of reference is undoubtedly of great practical and theoretical value and it should be useful in lecture-room or classroom work for showing the properties of the elements in connected form.

It would be interesting to try projecting the coloured charts on a screen with an epidiascope.

F. H. Loring.

Les Diastases. By Prof. Henri Colin. *Part I. Les Hydrolases.* Pp. 320. Paris : G. Doin. 1931. Price 30 francs .

From the observations of Dubrunfaut (1823) and Mitscherlich (1826) to the latest announcements concerning the glycosidases, proteases and esterases is a far cry. Prof. Colin, who is perhaps one of the most prominent of French biochemists, has now published a very comprehensive and read-

able account of the hydrolytic enzymes, prefering, it would seem, the older term *diastase* rather than the more general term *ferment.* He describes the nature and general characteristics of the hydrolytic enzymes, together with their preparation, use and specific action. Their biology and function in living organisms are also referred to, and the limits of their activities, dependent upon the tolerance of the cell life, receive adequate attention. The book will be of interest to chemists in general and of special interest to organic and biochemists.

Forthcoming Events.

FRIDAY, JANUARY 8.

S.C.I. *Glasgow Section.* Eglington Hotel, Ardrossan, at 7.15 p.m. Ardeer and other Societies by invitation. Ardeer Smoking Concert.

SATURDAY, JANUARY 9.

ROYAL INSTITUTION. 21, Albemarle Street, W.1, at 3 p.m. Christmas Lectures. " Light from the Sun and the Stars," by Sir William Bragg, F.R.S.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY. *Chemical Section.* 36, George Street, Manchester, at 7 p.m. Soirée.

MONDAY, JANUARY 11.

INSTITUTE OF METALS. *Scottish Section.* 39, Elmbank Crescent, Glasgow, at 7.30 p.m. " Some Properties of Fire-Bricks," by H. C. Biggs.

INSTITUTION OF ELECTRICAL ENGINEERS. *Western Centre.* Annual Dinner at Cardiff.

TUESDAY, JANUARY 12.

INSTITUTE OF METALS. *North-East Coast Section.* Armstrong College, Newcastle, at 7.30 p.m. " Defects in Non-Ferrous Castings," by R. Dowson, S .G. Homfray, and A. Logan.

INSTITUTE OF METALS. *Birmingham Section.* Chamber of Commerce, Birmingham, at 7 p.m. " Stainless Steel," by J. H. G. Monypenny.

INSTITUTION OF PETROLEUM TECHNOLOGISTS. *General Meeting.* Royal Society of Arts, John Street, Adelphi, W.C.2, at 5.30 p.m.

TUESDAY, JANUARY 12, and WEDNESDAY, JANUARY 13.

FARADAY SOCIETY. University, Oxford. General Discussion on " Adsorption of Gases." General Introduction by Prof. H. S. Taylor. Section I. " Experimental Methods," Introductory Paper by Prof. E. K. Rideal. Section II. " Kinetics and Energetics," Introductory Paper by Prof. H. Freundlich. Section III. " Theories of Adsorption," Introductory Paper by Prof. M. Polanyi.

WEDNESDAY, JANUARY 13.

S.C.I. *Montreal Section.* Mount Royal Hotel, Montreal, at 8 p.m. " Romance of Insulin and Recent Developments in the Connaught Laboratories," by Dr. J. G. FitzGerald.

THURSDAY, JANUARY 14.

S.C.I. *Yorkshire Section.* Joint meeting with the Leeds Area Section of the Institute of Chemistry. " Recent Developments in the Treatment of Boiler Waters," by Dr. A. W. Chapman. By invitation of the Institution of Mechanical Engineers (Yorkshire Branch).

INSTITUTE OF CHEMISTRY. *Leeds Area Section.* Joint Meeting with the Yorkshire Section of the Society of Chemical Industry. (See above.)

S.C.I. *Nottingham Section.* University, Nottingham, at 7.30 p.m. " Lime and Limestone," by W. Woodhouse.

INSTITUTE OF CHEMISTRY. *Manchester and District Section.* College of Technology, Manchester, at 7 p.m. " Teaching of Applied Chemistry and Facilities for Specialised Post-Graduate Work," by C. H. Creasey.

OIL AND COLOUR CHEMISTS' ASSOCIATION. *London Section.* 30, Russell Square, W.C.1, at 7.30 p.m. " Earth Colours," by W. Armstrong Storey.

FRIDAY, JANUARY 15.

S.C.I. *South Wales Section.* Joint meeting with the South Wales Section of the Institute of Chemistry. At Neath, at 7.30 p.m. " Future of Liquid Fuels," by Dr. A. E. Dunstan.

INSTITUTE OF CHEMISTRY. *South Wales Section.* Joint meeting with the South Wales Section of the Society of Chemical Industry. (See above.)

S.C.I. *Manchester Section.* 17, Albert Square, Manchester, at 7 p.m. "Some Aspects of Boiler Water Chemistry," by H. E. Jones.

CHEMICAL ENGINEERING GROUP. Burlington House, Piccadilly, W.1. "The Preparation of Emulsions," by W. Clayton.

SOCIETY OF DYERS AND COLOURISTS. *Manchester Section.* College of Technology, Manchester, at 7 p.m. "Beam Dyeing with Vat Colours," by J. R. S. Goodall.

PHYSICAL SOCIETY. Imperial College of Science, South Kensington, at 5 p.m.

TUESDAY, JANUARY 19.

S.C.I. *Birmingham and Midland Section.* Chamber of Commerce Buildings, Birmingham, at 6.45 p.m. "Application of X-ray Methods to Chemical Problems," by E. Gordon Cox.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by permission of the Controller of H.M. Stationery Office and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., price 1/- weekly (annual subscription, £2 10s.).

Latest Patent Applications.

35,000.—Böhme Akt.-Ges., H. T.—Process for reductions of carboxylic acids, etc. December 17.

34,738.—Hough, A. — Manufacture of organic nitrates. December 15.

35,106.—I. G. Farbenindustrie Akt.-Ges., and Johnson, J. Y.—Manufacture of sulphur dioxide. December 18.

35,122.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of pyridine derivatives. December 18.

34,564.—Jenaer Glaswerk Schoot and Gen. —Devices for generation of sulphuric acid. December 14.

Specifications Published.

362,908.—Collett, E.—Production of nitric acid.

363,009.—Baxter, J. P., Edwards, W. A. M., Winter, R. M., and Imperial Chemical Industries, Ltd.—Production of acetylene and vinyl chloride from ethylene dichloride.

363,149.—Mentzel, A. — Manufacture of sodium cyanide.

363,205.—Johnson, J. Y. (I.G. Farbenindustrie Akt.-Ges.) — Recovery of sulphuric acid from waste acids produced in the refining of mineral or tar oils.

363,218.—Jacob, A.—Manufacture of sal ammoniac and soda.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

Group Abridgments can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., either sheet by sheet as issued on payment of a subscription of 5s. per Group Volume or in bound volumes, price 2s. each.

357,329.—Acetic acid.—Bergstrom, K.G., and Zennstrom, A. F., 61, Rue Boursault, Paris.

In the treatment of ligneous vegetable materials which are rich in resin with a dilute alkaline lye of 1-2° Bé for a prolonged period—6 to 24 hours—at ordinary temperatures between 15-20° C., for the production of lignin which can be converted into cellulose, the lye after the treatment contains a considerable proportion of sodium acetate from which acetic acid can be recovered by known methods. Materials which are rich in turpentine can be treated as above and then the turpentine removed by treatment with steam, and the resin by heating with a strengthened lye. The bark from the trees can be treated by this method to obtain acetic acid. The acetate produced can be used to obtain substantially pure acetone.

The Latest Trade Marks

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

UKLOR.

527,501.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—W. A. Wayland & Co., Limited, U.K. Works, Gosterwood Street, Deptford, London, S.E.8. December 28.

THE CHEMICAL NEWS

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"GOLD FROM SAND."

By H. W. Blood Ryan, M.A., D.Sc., LL.D., Ph.D.

Whilst there is unmistakable evidence concerning the transmutation of certain radioactive elements into other chemical elements, it is doubtful whether any scientist of standing could be found who would place any credence in the claims to convert metals or non-metals into gold. Yet from time to time instances of such claims are reported. Thus, a few years ago M. Jollivet-Castellot published articles and books upon his methods of preparing gold from silver and orpiment (arsenic sulphide) He writes, "La transmutation de l' argent en or, la fabrication artificielle de l'or est donc une chose aujourd'hui nettement établie et dont il est facile de tirer des importantes consequences." (*Etudes d' Hyperchimie*, 1928, p. 174. Librarie Emile Noury, Paris.)

He describes several successful "projections." Thus in one case 22 gr. of silver were mixed with 3 gr. of orpiment (a sulphide of arsenic) and fused at a high temperature for ¾ of an hour, and repeating for a few minutes at intervals with further additions of orpiment. The cooled mass was subjected to the action of pure sulphide of antimony for five minutes causing the whole to become golden and actually exhibit the properties of gold. M. Jollivet Castellot has since given further instances in a second book *La Fabrication Chimique de l'Or* (French text, with English, German and Spanish translations). A chemical engineer, M. A. Ballandras, states that he has successfully, repeated M. Castellot's experiments. Reference is also made to the fact that the French Academy of Sciences and other bodies have persistently ignored M. Castellot's claims and even declined to criticise them.

In India Dr. Bhudeb Mookerji is engaged in compiling, in about ten volumes, *Rasa-Jala-Nidhi* or *Ocean of Indian Alchemy.** Like M. Jollivet Castellot he disclaims any desire to exploit his discoveries commercially.

* *Rasa-Jala-Nidhi*, or *Ocean of Indian Alchemy and Chemistry* by Dr. Bhudeb Mookerji, M.A., vol. I, pp. 376; vol. II, pp. 822; bilingual text in Hindustani and English. Price 15s. 1927.

Claims have been made in Germany within the last few years by Professor Miethe and Stammreich and by Professor Nagaoka in Japan of the conversion of minute amounts of mercury into gold by electrical means, it having been considered scientifically feasible that mercury (of atomic weight 200) would be degraded into gold (at. wt. 197) in the same way that radium (at. wt. 226) changes into lead (at. wt. 206). The claims of these scientists have been disputed. The gold which they found in the mercury after their experiments has been ascribed by critics to its previous presence.

Perhaps of greater interest to students of alchemy is the case reported recently by Prof. Traube (*Chemiker Zeitung*, 1928, lii, 2-4) who states that a man in the Erzgebirge actually extracted enough gold to sell to goldsmiths periodically, although assayers could not detect the precious metal in the minerals the miner used. Prof. Traube relates that he heard of this miner over 30 years ago and made his acquaintance soon after. The man used to go for three weeks at a stretch into the mountains and return with a copper ore known as Glimmerschiefer and which is regarded as free from gold. This ore was dissolved in aqua regia and evaporated to dryness, the residue yielding gold after removal of copper, etc. Prof. Traube suggests colloidal gold is present in the original mineral.

The latest claimant to success in transmutation is a Polish chemist, M. Dunikowski, who has had ample funds and a well equipped laboratory placed at his disposal. His starting material is sand (silica) obtained from the Riviera by an engineer compatriot of Dunikowski. It is subjected to special electrical treatment and exposed to the light from mercury vapour lamps. The sand is also brought into contact with radioactive matter and other reagents essential to the process. Afterwards the sand is heated to 1,400° C, treated with sulphuric acid and then the gold is extracted with mercury.

It is difficult to follow this rather unusual procedure and no announcements have yet been made as to costs and yield. In any case it is unlikely that the method will be a commercial success and reports in the French Press indicate that M. Dunikowski's Dutch sponsors are becoming apprehensive.

SOLVENTS OLD AND NEW.

By J. G. F. Druce, M.Sc. (Lond.), R.Nat.Dr. (Prague), F.I.C., F.C.S.

It can be safely asserted that many technical processes have suffered in the past through the employment of the wrong solvent. The importance of the correct use of solvents is well illustrated by Wohl's discovery in 1899 that cellulose is readily acetylated by acetyl chloride in the presence of pyridine. Acetylation had been effected earlier both with and without solvents, diluents or additional salts (*e.g.*, acetates) but these methods of making acetylated cellulose were unsatisfactory until Wohl's discovery was made. After this the process became easy and smooth to work in the presence of pyridine and a solvent for the cellulose acetate produced.

In the rayon industry the question of solvents is complicated by the fact that the compounds to be dissolved are colloids, *i.e.*, they do not form true solutions and the derivatives, especially the acetate and nitrate esters, vary widely in their general characteristics, including their solubility.

Cellulose triacetate, *i.e.*, fully acetylated cellulose, is not so soluble as the product obtained when this compound is partially regenerated into (somewhat degraded) cellulose. The triacetate, containing 44.8 per cent. "acetyl" group, is soluble in glacial acetic acid, acetylene tetrachloride, benzene dichloride and other halogen derivatives of the hydrocarbons, pyridine, nitrobenzene and especially in chloroform. Mixtures of ethylene dichloride and chloroform or an alcohol also dissolve it satisfactorily. This recalls the remarkable fact that cellulose nitrates are insoluble in alcohol or in ether alone and yet will dissolve in a wide range of mixtures of these two solvents. Acetone, which is one of the most useful of solvents, will not dissolve cellulose triacetate but is an excellent solvent for the partly hydrolysed esters containing about 40 per cent. "acetyl" group, which is known as "acetone soluble cellulose acetate." Other ketones such as methyl ethyl ketone, acetophenone and cyclohexanone also dissolve this partially hydrolysed cellulose acetate. When the acetyl content of the ester falls below 96 per cent. the ester is, however, no longer soluble in acetone.

It has become customary to classify solvents into "low-boiling" and "high-boiling" groups. The former are volatile and readily evaporate on exposure but the boiling point is really not a true index of solubility, especially in the case of mixtures of solvents. A case in point is afforded by butyl acetate and the corresponding butyl alcohol. The former boils at 126° C. and the latter at 114° C., yet the former evaporates much more rapidly although it has the higher boiling point. Amyl, phenyl and other acetates have been used extensively as solvents for cellulose esters either alone or with other diluents and although they all possess rather high boiling points they evaporate freely on exposure. The commercial samples of these acetates frequently contain about 15 per cent. of alcohol.

Another solvent which has recently received much attention is isopropyl alcohol, obtained by reduction of acetone. It boils at 81° C. and is finding wide application as a substitute for ordinary alcohol which boils at 78° C. It is especially serviceable when the denaturing bodies added in industrial methylated spirits are undesirable. Aniline (b.p 181°) and nitrobenzene (b.p 210°) are useful solvents for use at temperatures above that of boiling water.

The following is a list of the more important organic solvents in order of their boiling point.

	B.p in °C.
Ether	35
Ethyl bromide	37
Methyl iodide	42
Ethyl formate	54
Acetone	56
Methyl acetate	57
Methyl alcohol	65
Ethyl acetate	77
Ethyl alcohol	78
Benzene	80
Methyl ethyl ketone ...	81
Isopropyl alcohol	82
Isopropyl alcohol	87
Propyl alcohol	97
Ethyl propionate	99
Propyl acetate	102
Isobutyl alcohol	108
Toluene	110
Pyridine	115
Isobutyl acetate	116
Butyl alcohol	117

Ethyl butyrate	119
Methyl glycol	124
Diethyl carbonate	125
Ethylene chlorohydrin...	127
Isoamyl alcohol	131
Monochlorobenzene ...	132
Ethyl glycol	135
Isoamyl acetate	138
Xylene	138-142
Propyl butyrate	142
Ethyl lactate	155
Cyclohexanone	157
Methyl oxalate	163
Aniline	180
Phenol	183

OVER-PRODUCTION AS A FACTOR IN CHEMICAL PROGRESS.

By Louis Light, Ph.D. (Zurich), A.I.C.

Owing to the great progress in the sphere of chemical engineering combined with the clearer insight into the mechanism of reactions which has been gained in recent years, the difficulties confronting the manufacturer of to-day are not so much concerned with actual production as with the disposal of the enormous outputs which have been rendered possible. Intensive study of the various outlets for his accumulating stocks is being inexorably forced upon him and research work—instead of being relegated to a back seat—is gaining recognition as the road to economic salvation.

Twentieth century industrial history is rich in examples of the fertilising value of chemical research work. The definition of research as a fertiliser, it may be added, is justified on the ground that no finality can be reached in the condition of a particular industry; any release in the economic tension which a particular outlet for surplus materials may bring about must be regarded as a passing phase, since the same efficiency in production which created the initial economic difficulties will inevitably react in the same disconcerting manner on any subsequent process.

An excellent example of the vitalising power of scientific research is presented by the cellulose lacquer industry. The great bar to progress in this sphere had been the difficulty in producing a nitrocellulose of sufficiently low viscosity on the commercial scale, and it required the urgent necessity for disposal of the huge stocks of guncotton which accumulated at the close of the Great War to achieve the desired object. This was followed by a sensational increase in the output of nitrolacquers, the United States production amounting to 11 million gallons in 1925 followed by an enormous expansion to 27 million gallons in 1930. But progress did not merely limit itself to the manufacture of low viscosity nitrocellulose, for in the train of the latter followed an expansion of the spraying plant industry and the growth of flourishing subsidiary industries in connection with the manufacture of solvents, plastifiers and synthetic resins.

In the Haber-Bosch synthetic ammonia process, coke water gas is the main source of hydrogen and requires purification from the accompanying carbon monoxide. Comparatively little use was found for the latter until the critical economic condition of the synthetic plants in various countries stimulated investigations into the possibilities of its profitable utilisation and resulted in the successful hydrogenation to methyl alcohol. An immensely important consequence of the economic difficulties of the synthetic nitrogen industry was thus the opening out of an almost inexhaustible supply of formaldehyde. Since it is impossible to set a limit to the potentialities of this latter substance, access to a source of supply independent of the old wood distillation process is an achievement whose importance cannot be too strongly emphasised.

The history of calcium carbide throws into high relief the function of economic difficulty in the creation of new industries. Originally manufacture on account of the high hopes which were entertained in the latter years of the nineteenth century of the value of acetylene as an illuminating gas, the scope of calcium carbide has so extended as to render it one of the most important key materials of industry. There is no doubt that the disappointing reception accorded to illuminating acetylene by the general public represented the stimulus towards the discovery of new uses. Great engineering and chemical difficulties were successfully overcome and led to the large scale synthetic production of acetic acid, acetone, acetaldehyde, ethyl alcohol, cyanamide and urea.

In the artificial silk sphere, we see viscose manufacturers actively turning their attention to the production of transparent wrapping paper, a material which promises

to represent a far more profitable outlet for viscose than in the form of a textile, and yet the cellophane industry may not have reached its present dimensions in the absence of difficulties in the way of disposal of viscose rayon. As for the cellulose acetate silk industry, it is probable that the vast stocks of cellulose acetate aeroplane dope which became superfluous at the end of the Great War formed the principal factor in its foundation in this country. Furthermore, the general uncertainty of the rayon market is acting as a stimulus towards the explotation of both viscose and cellulose acetate in the field of plastic moulded products and safety glass.

Many other examples could be cited, but sufficient has been said to show that however unpleasant may be the economic stress under which the chemical industry—in common with most others—is now labouring, very tangible progress is taking place, and the common good is being served by a constantly increasing range of products never before equalled for quality and cheapness.

THE CANADIAN NICKEL INDUSTRY.

Ninety Per Cent. of World Production Supplied by Ontario Mines and Smelters.

Canada has, during the past few years, made rapid strides in the output of precious and base metals, and now occupies a far more important place in the world's metal markets than was the case only a very few years previously. Among the base metals in which Canada is prominent in the world's markets, nickel occupies an important position in view of the fact that the Dominion has almost a monopoly in the supply of this metal.

Exhibition in London.

The importance of the Canadian nickel industry is now being brought to the attention of the public by an interesting display in the windows of the Ontario Government Office in London (163, Strand). The exhibit is planned to illustrate the wide ramifications of the Ontario nickel industry, demonstrating the extent to which so many manufacturing industries in this country are now dependent upon nickel as well as upon monel metal—one of the most important of the nickel-coppel alloys derived from the Sudbury ore. In this rich mining district of Northern Ontario, nine-tenths of the world's supply of nickel is now being mined. In no other base metal is the world's known commercial supply so largely concentrated at one point of the earth's crust. In one mine alone (the Frood) there has been discovered already sufficient nickel for the supply of the world's requirements for many years, calculated at the recent rates of consumption. Another mine about 10 miles away has been supplying about half of the world's requirements for most of the present century, and is very far from exhaustion. These are only two out of the dozens of operating mines or known ore bodies that abound in the Sudbury district.

First Delivery in 1858.

The first authentic discovery of nickel in the Sudbury district was recorded by the Dominion Geological Survey as far back as 1858, when Alexander Murray had his attention called to the strong deviation of the compass near what is now the famous Creighton mine. The first discovery of ore in place was made in a rock cut on the main line of the Canadian Pacific Railway near what was later known as the Murray mine. News of the discovery started active prospecting, and among the men who came into the field were many whose names have become prominent in the later history of the industry: Thomas Frood, James Stobie, Renaldo McConnell, F. C. Crean, J. H. Metcalf, Thomas Baycroft, W. B. McAllister, F. Y. Eyre and William McVittie.

Nickel and the Navy—Wartime Utilisation of Metal.

Between 1884 and 1886, this group of prospectors located all of the now known large deposits, and, in addition they traced the occurrence fairly completely around the rim or border of what has since become famous as the Sudbury Basin. In 1886 public attention was drawn to the new discoveries, particularly in connection with their association with the fortunes of the Canadian Pacific Railway project then under construction. At the same time, the British Government was made acquainted with the qualities of Canadian nickel. The output of nickel was then about 1,000 tons per annum, and up to 1908 it was used chiefly for nickel-silver, coinage, and nickel-plating. However, a growing interest had been developed in nickel iron alloys; experiments made at a Glasgow steel works having been described in a paper read before

the members of the Iron and Steel Institute in London. This was the beginning of a new era of remarkable progress in the nickel industry. There arose a constantly increasing demand for nickel in armour plate, and nickel steel and ordnance, further expanded by the active naval competition between Great Britain and Germany. The demand continued to increase throughout the War period, and during the continuance of active hostilities the particular problem faced by the nickel industry was that of producing sufficient metal to satisfy the insatiable demand, the entire production being conserved for the Allies till the end of the War.

Setback to Industry After Washington Naval Conference.

Following the decisions of the Washington Naval Conference in 1921, the industry suffered a temporary setback, and the whole attention of the companies concerned was concentrated on the maintenance of the of the remaining markets and the development of new ones. The success of their efforts will be readily grasped by consideration of the fact that production is now on a par with the peak years 1916-1917. The majority of products into which nickel goes to-day are engineering materials. The need, therefore, for competent research in promoting industrial uses of nickel products has been recognised, and a special department of engineering development and research has been created. It is a function of this department to secure the necessary engineering information on all metal products and to bring that information to bear effectively on every potential user. It provides much of this information in the form of special articles published by technical societies in periodicals. It maintains contact with industrial engineers, bringing a knowledge of nickel products directly to their aid in the solution of their problems, and at the same time keeping in touch with their engineering material requirements. To-day more than sixty different compositions and types of nickel steels and alloys are in commercial use. These products are sold to and utilised by perhaps 10,000 manufacturers of machinery and equipment. Of the nickel-copper alloys the most interesting are those containing 65 per cent.—70 per cent. nickel. Among the most important of these is monel metal, the discovery and development of which is another romantic feature of the nickel industry.

Nature's Own Nickel-Copper Alloy—Monel Metal.

In the early days, methods had been developed for separating the nickel and the copper mined in the Sudbury area, but early in 1904 it was decided to smelt out the two metals simultaneously and to examine the commercial merits of the resulting alloy. Investigation showed this alloy to be superior to pure nickel, not only as regards the mechanical properties such as strength, toughness, etc., but also as regards resistance to corrosive action. The alloy contains approximately two-thirds nickel and one-third copper, and was named after Mr. Ambrose Monel, a former President of the International Nickel Company. The present consumption of Monel metal is approximately 1,400 tons per month. This natural nickel alloy has been subsequently found by research to be the most valuable of the whole nickel-copper series as regards strength and resistance to corrosive action.

The versatility of Monel metal is particularly demonstrated in the exhibit at the Ontario Government Office, and the entire exhibition is an effective example of industrial co-operation between two of the principal manufacturing countries of the British Empire.

AUTOMATIC HANDLING SPECIALISTS SIGNIFICANT MOVE.

Redler Patents are announcing a reduction in their prices—something of an event, as their charges hitherto have been unchanged since their machines were first manufactured.

The reasons given for the change are that their System of Modern Bulk Conveying is now spreading so rapidly and widely that the firm wishes its clients to share in the lowered costs of production resulting from this state of things.

The depreciation of sterling abroad and the prospect of tariffs in this country would appear to indicate caution in any question of lowering prices, but Redler Patents seem confident that to make the advantages of their System available at competitive prices will more than outweigh any political considerations.

REVIEW OF WORLD CHEMICALS.

FRENCH CHEMICAL EXPORTS FELL 9 PER CENT. IN 1930.

France ranks fourth among the world's chemical-producing countries. Notwithstanding the depression, its chemical exports in 1930 of £25,000,000 were only 9 per cent. less than in the previous year. Imports of chemicals into France in 1930 had a value of £20,000,000 which was a decline of only 8 per cent. as compared with 1929.

GUM ARABIC EXPORTS FROM EGYPTIAN SUDAN LOWER IN 1931.

Gum arabic exports from the Egyptian Sudan during the first half of 1931, while comparable in quantity with total shipments in the corresponding period of 1930 was less in value £400,000 against £700,000. Great Britain took £100,000 worth in the 1931 period while the United States was second with purchases, totaling £70,000.

TUNG OIL EXPORTS FOR OCTOBER.

Total exports of tung oil from Hankow during October reached 10,426,000 pounds, of which 6,384,000 pounds went to the United States and 4,402,000 pounds to Europe. The total consignment to Europe is over 2,000,000 pounds in excess of average monthly shipments. It is estimated that stocks on hand at Hankow the end of October amounted to 600 short tons.

LUKENS STEEL COMPANY FOUNDS INDUSTRIAL FELLOWSHIP AT MELLON INSTITUTE.

Dr. Edward R. Weidlein, Director, Mellon Institute of Industrial Research, Pittsburgh, Pa., has announced that tbe Lukens Steel Company of Coatesville, Pa., has established in the Institute an Industrial Fellowship whose purpose is the scientific investigation of processes employed in the manufacture of steel plates. Erle G. Hill, who received his professional education at the University of California, has been appointed to the incumbency of this Fellowship. He is a specialist in iron and steel technology and was previously associate professor of metallurgy in the School of Mines of the University of Pittsburgh.

COSACH NITRATE FINANCING ARRANGED.

Medley G. B. Whelpley, member of the firm of Guggenheim Brothers, states :—

"Through agreements concluded with the Chilean government, and by assistance of Guggenheim Brothers, with the company's English and American bankers, arrangements have been made to provide for current financial requirements of Compania de Salitre de Chile (Cosach) during the remainder of the present nitrate year which continues until June 30, 1932.

"An invitation has been extended by the Chilean Government, which has been accepted by the company, to hold further conferences with the government in Chile, and with holders of the company's obligations, and others interested in the company, through which it is hoped a permanent accord may be reached."

ARGENTINE FLAXSEED SHIPMENTS ON A LARGE SCALE.

Shipments of flaxseed from Argentina continue on a comparatively large scale, according to Department of Agriculture. Trade reports place such shipments from September 1 to November 7 at 12,795,000 bushels, or about twice as much as for the corresponding period last year. From January 1 to November 7, 1931, total exports from Argentina were 71,808,000 bushels against 41,987,000 bushels for the corresponding period of 1930. The total imports into the United States and the United Kingdom during September of this year were approximately five times larger than the receipts for the same month last year. In the United States 2,469,000 bushels were imported September, 1931, against 59,000 bushels September, 1930.

NEW CAUSTIC SODA PLANT IN ARGENTINA.

During the past six months a new plant has been operated in Rosario, Argentina, for the production of cellulose paper and the by-products, caustic soda, and hydrochloric acid. A ready market has been developed for the by-products now produced at the rate of 50 metric tons a day of salt, 10 tons liquid caustic soda, and 5 tons of muriatic

GERMANY IMPORTANT MARKET FOR AMERICAN PINE OIL.

Germany, as one of the most highly industrialised nations of the world, offers a particularly fertile market for the sale of pine oil. It is only recently that German industries and chemists have become aware of the increasing uses to which this commodity can be placed. Pine oil is used primarily in Germany as an emulsifying agent, solvent and source of terpineol and terpene hydrate. Its utilisation as a deordant, germicide, insecticide, and denaturant is not as important proportionally, as in the United States. Increased demand for the product should come from the German lead and zinc mines for use as a flotation agent; from the soap industry and from textile plants for washing textiles. The use of the oil as a solvent for nitrocellulose and as an addition to spinning solutions is of only recent application in Germany. Greater production by German manufacturers of disinfectants, rubber, lacquers, dyes, and artificial silk offer excellent opportunities for expanding sales of the oil. German imports of pine oil in 1930 amounted to 3,000 barrels (barrels of 50 gallons) or a gain of 500 barrels over 1929.

" SEIZE A CAOUTCHOUC HOSE."

This is the effort of a Frenchman writing instructions in " English " for the construction of apparatus which required the use of a piece of rubber tubing. Such absurdities of mistranslation can be something more than a joke. To the business man it can and does mean loss of trade. To the manufacturer and his scientific and technical staff it can mean waste of time and expensive mistakes. Translation is not as simple as taking bricks out of a cart and putting them into another. It is beset by pitfalls, and reliable translations can be made only by those who are expert not merely in the languages concerned but also in the subject matter of the work. There has always been difficulty in finding competent translators but the establishment of the ASLIB Panel of Expert Translators by the Association of Special Libraries and Information Bureaux went a long way to solve it. The range of languages and special subjects covered by this service is now very wide.

SOVIET CODE SCARE OVER CHEMICAL CHART.

Soviet officials recently refused to allow a copy of the Periodic Chart of the Elements, one of Russia's greatest contributions to chemistry, to pass through the mails entering that country, believing it to be some form of foreign code message, according to Prof. Herbert R. Moody, director of the chemistry laboratories of the City College of New York and a member of the American Chemical Society.

" The University of St. Petersburg had only a photostat copy of the Periodic Chart of the Elements, so one of the City College students, a White Russian, got two copies and sent them to his sister, who is a student at that University," Prof. Moody discloses.

" Our student had formerly been in the Intelligence Service of the White Russian Army and naturally the Soviet officials held him ' persona non grata,' and it was largely because of his name on the package that it was opened for inspection.

" However, in spite of its obvious nature, it was not allowed to go into the country and it was returned to this country.

" Thus the Soviet officials put themselves in the position of refusing to allow entrance to what is probably one of Russia's greatest contributions to chemistry. They held that the chart, being unintelligible to them, must be a cipher bringing in information from the outside."

IMPORTS OF SULPHUR IN PARAGUAY.

The greatest demand is for agriculture and sugar refining. No sulphur is mined locally. During 1930 the imports were 848 metric tons valued at £4,000. Sulphur received from Argentina was valued at £3,000 and from Italy £1,000.

NEW SYNTHETIC RUBBER FROM PETROLEUM IN MEXICO.

Large scale production of automobile tyres, rubber heels and other rubber products from synthetic rubber made from petroleum is due to start in Mexico in January. Julio Tellez Giron, research chemist who perfected the process after 17 years' experiment, told the United Press that the Compania Hulera Mexicana of

which ex-President Plutarco Elias Calles is president, would have a plant in operation by January which would produce between 300 and 400 tyres and 5,000 rubber heels daily.

SUPERPHOSPHATE IMPORTS INTO THE UNITED STATES.

During the three months ended September these totalled 4,156 long tons, of which Cuba supplied 3,000 tons and Japan 1,156. All of the Cuban material was entered in Porto Rico, while receipts from Japan were distributed in the following customs districts: San Diego, 25 tons; Los Angeles, 355; San Francisco, 22; Washington, 546; and Hawaii, 208 tons. Superphosphate was not separately listed in official import statistics previous to July 1, 1931.

FERTILISER FROM SUGAR WASTE IN HAWAII.

With more than 200,000 tons of molasses going to waste annually, the Hawaiin Sugar Planters' Association's experimental station has perfected a process for the manufacture of fertiliser from molasses which has all the essential elements of types which are now being imported. It is estimated that manufacture on large scale will be profitable. It is stated that the process will be retained solely for the use of the island's sugar industry.

CANADA'S MINERAL PRODUCTION IN 1931.

In spite of the decline in prices of most minerals, the mining industry of Canada is in a robust condition and is in a position to take full advantage of the expected upward economic turn.

Canada's mineral production in 1931 was valued at 227,769, 000 dollars as compared with 279,873,000 in 1930, according to the preliminary estimate of the Dominion Bureau of Statistics.

Gold Production.

Gold production, stimulated by lower commodity prices and the present exchange situation, increased by 27.5 per cent. over 1930 and assisted materially in offsetting the loss occasioned by the drop in the prices of other metals.

The output of gold, which was the greatest yet recorded in the history of Canada, rose from 2,102,000 ounces valued at 43,458,000 dollars in 1930 to 2,680,000 ounces valued at 55,395,000 dollars. The bullion was paid for by the Canadian Mint at the New York rate for gold. As in other years production in 1931 was valued at the standard rate of 2,067 cents per ounce.

Copper.

Copper production amounted to 290,581,000 pounds valued at 23,772,000 dollars as compared with 303,478,000 pounds valued at 37,948,000 dollars, a decline of 37 per cent. in value and 4 per cent. in quantity over 1930.

Lead.

The production of lead amounted to 267,851,000 pounds valued at 7,241,000 dollars as compared with 332,894,000 pounds valued at 13,103,000 dollars.

Nickel.

The production of nickel amounted to 66,104,000 pounds, which is considerably under the total for 1930.

Silver.

Silver production amounted to 20,404,000 ounces valued at 5,984,000 dollars as compared with 26,444,000 ounces valued at 10,089,000 dollars.

Zinc.

Zinc production amounted to 236,861,000 pounds, which is 11 per cent. under 1930 production.

Fuels.

Fuels including coal, natural gas and crude petroleum totalled 55,531,000 dollars as compared with 68,184,000 dollars in the previous year.

Coal production amounted to 12,252,000 short tons valued at 41,320,000 dollars, a decrease of 18 per cent. in quantity and 22 per cent. in value.

The production of natural gas, of which 69 per cent. came from Alberta, amounted to 26,875,000 cubic feet valued at 9,645,000 dollars, a decline of 8 per cent. in quantity and 6 per cent. in value.

Production of crude petroleum amounted to 1,555,000 barrels valued at 4,566,000 dollars, a slight increase in quantity but a decline in value as compared with 1930.

The production of asbestos amounted to 162,276,000 tons, which was considerably lower than in 1930.

U.S. CHEMISTS BATTLE OVER BEST TYPE OF CATALYST.

Institute of Chemical Engineers Begins With Discussion of Pollution and Then Winds Up With Vanadium—Platinum Catalyst Controversy.

(From our New York Correspondent.)

Declaring war on stream, harbour and beach pollution and seeking a solution of this far-reaching problem was the first action — through a symposium — of the Atlantic City meeting of the American Institute of Chemical Engineers which opened on Wednesday, the 9 December, 1931. This was the 24th annual convention of this body and the sessions continued through Friday.

Seven chemical engineers, including state engineers of New Jersey, Pennsylvania and Connecticut participated in the symposium on Wednesday. The speakers on the programme for the two-day sessions included: Dr. Thorndike Saville, professor of hydraulic and sanitary engineering of the University of North Carolina; Dr. Edward Bartow, professor of chemical engineering of the University of Iowa; W. L. Stevenson of Harrisburg, chief engineer of the Pennsylvania State Department of Health; William B. Wise of Hartford, State Water Commissioner of Connecticut; Dr. William Rudolfs of the Department of Water Supplies and Sewage Research, New Jersey State Agricultural Experiment Station, and Robert S. Weston of Boston and Edmund B. Besselievre, New York chemical engineers.

Dr. John C. Olsen, president of the Brooklyn Polytechnic Institute, also president of the association, was in the chair. Philadelphia.

Dr. John Van Nostrand Door, president of the Dorr Company Inc., New York City, was elected president, to succeed Professor Olsen. Albert E. Marshall, consulting chemical engineer, also of New York, was chosen vice-president.

The following were re-elected: Frederick J. Le Maistre of Philadelphia, secretary-treasurer, and Martin J. Ittner, chief chemist with the Colgate-Palmolive-Peet Company, Jersey City, N. J., auditor.

Four new directors were elected to the board to serve for three years. They are: Willard H. Dow, president of the Dow Chemical Company, Midland, Mich.; Robert T. Haslam, vice-president and general manager, Standard Oil Development Company, New York City; Howard C. Parmelee, vice-president and editorial director, McGraw-Hill Publishing Company, New York, and James G. Vail, chemical director, Philadelphia Quartz Company, Philadelphia.

The relative merits of platinum versus vanadium as a catalyst in the manufacture of sulphuric acid, a product fundamental to the chemical industry and of a commercial importance comparable to that of pig iron, was the subject of a lively discussion during the closing session.

The controversy was precipitated by a paper presented by Dr. A. Paul Thompson of the International Nickel Company of New York, giving figures in support of the theory that, while the initial cost of platinum as a catalyst is greater than that of vanadium, the former metal offers advantages which more than offset the difference in price.

Albert E. Marshall, vice-president of the institute, contended, on the other hand, that the largest manufacturer of sulphuric acid in U.S.A. has recently substituted vanadium for platinum in some of its plant units. Other speakers said that it is still too early to determine the relative merits of the two, as vanadium has been used for only a few years.

Since our national supply of platinum is not large enough for our needs in case of war, Frederick C. Zisbberg of the du Pont Company pointed out that the development of vanadium as a catalyst must be considered an important factor in national defence.

In a paper presented by Henry L. Coles and James R. Withrow of Ohio State University, it was reported that new steels and alloys made from zirconium, the object of many years of elusive research by American investigators, have at last been produced in the laboratory by a process offering commercial possibilities.

NEW PRESIDENT-ELECT OF THE AMERICAN CHEMICAL SOCIETY FOR 1933.

Professor A. B. Lamb, of Harvard University, has been elected president of the American Chemical Society for the year 1933. The president for 1932 is Dr. L. V. Redman vice-president and director of research of the Bakelite Corporation, Bloomfield, N. J., who succeeds Prof. Moses

Gomberg, of the University of Michigan, on January 1.

The Society elects each year a president and a president-elect who serve in successive years. The following directors were elected :—

E. M. Billings, Eastman Kodak Company, Rochester, N. Y., for the second district comprising the states of New York and New Jersey; Prof. Roger Adams, University of Illinois, Urbana, for the fifth district, which includes Illinois, Indiana, Michigan, and Wisconsin.

R. E. Wilson, director in charge of the Development and Patent Department of the Standard Oil Company of Indiana, Chicago, was named director at large. Mr. Wilson is chairman of the Society's Division of Industrial and Engineering Chemistry.

These councillors at large were chosen : G. J. Esselen, Boston; Prof. R. A. Gortner, University of Minnesota; Prof. E. E. Reid, Johns Hopkins University, and E. R. Weidlein, director of Mellon Institute of Industrial Research, Pittsburgh.

Prof. Lamb, editor of "The Journal of the American Chemical Society," since 1917, was born in Attleboro, Mass., February 25, 1880. He received from Tufts College the A.B. and the A.M. degrees in 1900, the Ph.D. in 1904, and the D.Sc. in 1922. Harvard conferred on him the A.M. in 1903 and the Ph.D. in 1904. He has also studied at the Universities of Leipzig and Heidelberg.

In 1905-1906 he was instructor in electrochemistry at Harvard. From 1906 to 1912 he taught at New York University, where he was director of the Havemeyer Chemical Laboratory. Since 1912 he has been a member of the Harvard faculty, and director of the chemical laboratory.

In 1918-1919 Prof. Lamb was a colonel in the research division of the Chemical Warfare Service, U.S.A., in charge of defence chemical research. He served on the United States Fixed Nitrogen Mission in 1919, and from 1919 to 1921 was director of the Fixed Nitrogen Research Laboratory in Washington.

He is a fellow of the American Academy of Arts and Sciences, and a member of the American Electrochemical Society, the Washington Academy of Sciences, the National Academy of Science, and of Phi Beta Kappa, Delta Upsilon, and Alpha Chi Sigma.

THE CHEMISTRY OF THE ESSENTIAL OILS.

Being a Review of the Third Edition of Gildemeister and Hoffmann's *Die Ätherischen Öle.*

By H. Stanley Redgrove, B.Sc., F.I.C.

The essential oil industry is one of those industries of which the general public knows little or nothing. Indeed, it is possible that the majority of folk are oblivious of its existence, in spite of its large dimensions and great importance. The reason is simple. Although the public utilise and consume large amounts of essential oils, they employ them, not as such, but in the forms of scent, perfumed toilet requisites including scented soap and cosmetics, flavouring essences, liqueurs, and various foodstuffs (ranging from sweetmeats to sausages) flavoured by their aid. A number of the essential oils are also used in medicine.

Always important, the essential oils have become still more important in this country owing to the recent change in our fiscal policy. This change must inevitably lead to an increased demand for the various commodities mentioned above of British manufacture. It is very desirable, therefore, that the ranks of British chemists specialising in the chemistry of the essential oils should be increased. We must know everything that is to be known concerning this branch of chemical science.

It is an abtruse branch. In general, the composition of the essential oils is highly complex, and constituents present in quite minute amounts frequently exercise a powerful effect on their odours and flavours, the characters which make them of economic importance.

Gildemeister and Hoffmann's monumental treatise on the essential oils is well known. The second edition has been translated into English. The third German edition has recently been completed by the publication of the third and last volume and the index volume, and the four beautifully bound, beautifully printed books are in front of me as I write.*

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* *Die Ätherischen Öle* von E. Gildemeister und Fr. Hoffmann. Dritte Auflage von E. Gildemeister. 9 ins. × 6¼ ins. Vol. 1, pp. xvi+884+2 plates. Vol. 2.

I regard them with mixed feelings. As an Englishman, I cannot but feel regret that it has not been possible to produce in my own country any work on the essential oils which will bear comparison with them. As a chemist specially interested in the essential oils, contemplating them fills me with a feeling of relief. What hours of tedious searching through various scientific journals, some by no means easy to come by, these volumes will save. For here we have an account of the essential oils as complete, up to the date of the publication of the last volume, as German thoroughness can make it. Nothing has been overlooked, and the reader's convenience and pleasure seems always to have been considered. This is exemplified, for example, by the publication of the Index as a separate volume, by the inclusion of the Tables for laboratory use in duplicate form, as a little booklet neatly tucked into a band at the end of Volume 1, and by the very numerous illustrations including several full-page plates beautifully reproduced in colour, and a number of useful maps.

For the information of readers who are not essential oil chemists, it may be added that the firm responsible for the publication of the work is known throughout the world as one of the leading houses specialising in the production of essential oils and the manufacture of aromatic chemicals (known in the perfumery trade as "synthetics"). In their laboratories, an immense amount of work has been done on the chemistry of essential oils, the results of which have been published, though, so complex is the subject, that it would seem that only the fringe has been touched, so many are the problems that still await solution.

Volume I opens with a historical introduction (260 pp.). It includes histories of the more important essential oils and the spices and other aromatic plant-products from which they are obtained, and a history of distillation enriched with many illustrations, including several reproductions of drawings of ancient alembics, etc., from alchemical works. A short section (26 pp.) follows, dealing with extraction methods (including extraction with volatile solvents, enfleurage and maceration). The chief constituents of the essential oils and artificial perfume-materials are then described in detail (898 pp.). The final section of the volume (139 pp.) deals with the methods of testing essential oils, including the determination of physical constants, methods of chemical analysis, detection of common adulterants, etc.

Volumes 2 and 3 are taken up with the detailed individual treatment of the essential oils. The oils are grouped in accordance with the botanical classification of the plants from which they are obtained. The more important of the Natural Orders dealt with in Volume 2 include *Usneaceæ*, *Taxaceæ*, *Pinaceæ*, *Gramineæ*, *Araceæ*, *Liliaceæ*, *Amaryllidaceæ*, *Iridaceæ* , *Zingiberaceæ*, *Orchidaceæ*, *Piperaceæ*, *Myricaceæ*, *Betulaceæ*, *Moraceæ*, *Santalaceæ*, *Aristolochiaceæ*, *Chenopodiaceæ*, *Caryophyllaceæ*, *Ranunculaceæ*, *Magnoliaceæ*, *Anonaceæ*, *Myristicaceæ*, *Lauraceæ*, *Cruciferæ*, *Resedaceæ*, *Hamamelidaceæ*, *Rosaceæ*, *Leguminosæ*, *Geraniaceæ*, *Zygophyllaceæ* and *Rutaceæ*; whilst the more important of the Natural Orders dealt with in Volume 3 comprise *Rutaceæ* (conclusion), *Burseraceæ*, *Euphorbiaceæ*, *Anacardiaceæ*, *Vitaceæ*, *Malvaceæ*, *Dipterocarpaceæ*, *Cistaceæ*, *Violaceæ*, *Myrtaceæ*, *Umbelliferæ*, *Ericaceæ*, *Oleaceæ*, *Verbenaceæ*, *Labiatæ*, *Valerianaceæ*, and *Compositæ*. This volume also contains details concerning some essential oils whose botanical origins are not known, a supplement containing information concerning essential oils omitted from the systematic treatment, and a Table of flash-points. The work can be reveiwed in eight words: it is a complete account of the subject. Nothing more remains to be said.

In addition to publishing this work, absolutely indispensable to the essential-oil chemist, Messrs. Schimmel and Co., also issue each year a *Bericht*, containing a summary of recent developments, and which forms, in a sense, an annual supplement to *Die Ätherische Öle*. English translations of the *Bericht* are also issued, the latest to hand being the translation of the

pp. xxiii+959+10 plates. Vol. 3, pp. xxxi+1,072+14 plates. Index Vol. pp. 124. Miltitz (near Leipzig), Germany: Messrs. Schimmel and Co., Aktiengesellschaft (London Agents, Fredk. Boehm, Ltd., 17, Jewry Street, E.C.3.). Price: Vol. 1, RM. 32; Vol. 2, RM. 36; Vol. 3, RM. 40; Index Vol., RM. 6.50.

edition of 1930.† It contains 195 pages closely packed with information and two full-page plates. There are over 80 pages of "Commercial notes and scientific reports concerning volatile oils," arranged alphabetically under the names of the oils, over 70 pages of "Notes on scientific research in the domain of the chemistry of odorous substances," as well as notes on chemical preparations and drugs, details of the requirements of the Brazilian and the new Italian pharmacopœias concerning essential oils, and a note, under the heading "Novelties," giving some particulars about Carinthumpa oil. The only criticism that might be offered of this excellent Report is that it is not indexed.

THIRD INTERNATIONAL CONGRESS OF SANITARY TECHNICS AND URBAN HYGIENE.

The Third International Congress of Sanitary Technics and Urban Hygiene will take place at Lyons, from the 6th to 9th March, inclusive, 1932. The Organisation Committee has already received numerous applications for membership forms from participants from all European countries, from North and South America, and from the Colonies.

The questions to be submitted to discussion are as follows :—

1st Section.

Transport Hygiene.—Railway companies; general carriers; automobiles; garage hygiene.

2nd Section.

Habitation Hygiene.—(*a*) individual, (*b*) collective; building materials; house drainage; hygienic cleaning and upkeep of buildings; thermical mineral waters; heating; refrigeration; aeration; ventilation; lighting; daylight and artificial; workmen's dwellings; economical dwellings.

Places of Assembly Hygiene.—Schools, baths and swimming baths; assembly halls and theatres; sanitary legislation for dwelling houses; art in sanitary technics of buildings; slaughterhouses.

3rd Section.

Hospitals.—Constructions; plans; fitting up and internal arrangement.

Social Work.—First aid stations; creches and nurseries; dispensaries; aid to mothers.

4th Section.

Atmospheric Problems. — Fogs; smoke; dust.

5th Section.

Disinfection.—Principles; procedure and apparatuses for public service and private usage; insects' pests; destruction of vermin; street rubbish and household refuse; prophylactic regulations and means of combating infectious diseases; special prophylactic measures for tuberculosis.

6th Section.

Industrial Hygiene and Prevention of Accidents.—General principles and means of improving industrial sanitary conditions; collective and individual protection; special aspects of sanitary technics for factory and workshop application; thermal mineral waters; ventilation; lighting and upkeep; examples of sanitary application to various industries in particular; dispersion of harmful vapours and absorption of industrial dust; legislation of industral sanitary improvements and hygiene for workers.

During the Congress the annual provincial meeting of the "Syndicate of Medical Hygienists of France" will be held. An "Engineers and Architects' Day" will be organised, during which participants will be able to visit the important public works recently constructed at Lyons.

The French Railway Lines and various foreign railway companies are issuing tickets at a reduction of 50 per cent. in connection with the Fair and Congress, and facilities have been granted in the majority of countries to Members of the Congress.

To increase the interest in the Congress, an International Exhibition of Sanitary Technics and Urban Hygiene will be held in the buildings and during the International Lyons Fair, from March 7th to 20th inclusive, 1932.

All particulars will be sent on request on application to the Commissaire Général: Docteur Garin, Professeur Agrégé at the Faculty of Medicine, Médecin de l'Hôtel-Dieu, Municipal Councillor, Rue Ménestrier, Lyons, France.

---

† *Annual Report on Essential Oils, Synthetic Perfumes, etc.*, published by Schimmel and Co., Aktiengesellschaft. Edition of 1930, translated by Roland E. Kremers, Ph.D. $8\frac{3}{4} \times 6\frac{1}{4}$ ins., pp. 195. (London Agents, Fredk. Boehm, Ltd., 17, Jewry Street, E.C.3.)

INSULATING BOARD FROM PEAT LITTER.

The Carlson Building Company of Edmonton, Alberta, early in October, started the production of "Mosstex," a new building insulator manufactured from muskeg litter, and contemplates expansion into Manitoba. The new wallboard is said to possess excellent insulating and acoustic properties and to compare favourably with similar products manufactured from wood pulp and other fibrous materials.

The development of commercial uses for muskeg litter is of great importance to Canada, as large areas of muskeg and peat occur in practically every province. Experiments are now being conducted to determine the cellulose content of various deposits, particularly along the line of the new Hudson Bay Railway, where large areas are to be found in close proximity to the railway, and upon this factor will depend the suitability of the raw material for the manufacture of paper stock, coarse wrapping paper, and similar products. It is the sphagnum moss on which attention is particularly focussed and this material is stated to be admirably suited to the manufacture of litter, packing and insulating material, wallboard and possibly paper.

KEY INDUSTRIES.

A representation has been made to the Board of Trade under Section 10 (5) of the Finance Act, 1926, regarding barium silicofluoride.

Section 10 (5) of the Finance Act, 1926, is as follow :—

"The Treasury may by order exempt from the duty imposed by section one of the Safeguarding of Industries Act, 1921, as amended by this Act, for such period as may be specified in the order, any article in respect of which the Board of Trade are satisfied on a representation made by a consumer of that article that the article is not made in any part of His Majesty's Dominions in quantities which are substantial having regard to the consumption of that article for the time being in the United Kingdom, and that there is no reasonable probability that the article will within a reasonable period be made in His Majesty's Dominions in such substantial quantities."

Any communication should be addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, S.W.1, within one month from the date of this notice.

Proceedings and Notices of Societies

THE CHEMICAL SOCIETY OF JAPAN.

Papers communicated :—

Catalytic Chlorination. III. Action of Chlorine on Cyclohexene in Presence of Reduced Copper. By SHIGERU KOMATSU and TOKIO KAWAMOTO.

Studies on Proteins. VIII. Milk Casein. II. By SHIGERU KOMATSU and TAKEHIKO NAGAI.

Studies on Proteins. X. Rice Glutelin. By SHIGERU KOMATSU and YOSHITADA KINOSHITA.

Studies on Proteins. XII. Egg Albumin. By SHIGERU KOMATSU and YAHITO KOTAKE.

Studies on Proteins. VI. Wheat Gliadin. I. By SHIGERU KOMATSU and TAKEHIKO YUKITOMO.

Studies on Proteins. VII. Wheat Gliadin. II. By SHIGERU KOMATSU and TAKEHIKO YUKITOMO.

Studies on Amino Acids. I. Synthesis of Amino Alcohols. By YASUO YAMANA.

On the Basic Constituents of Low Temperature Coal Tar. By SHIGERU KOMATSU and AKITOKI MOHRI.

On the Determination of Vanadium, Niobium, Tantalum and Nitrogen. (Studies on Gravimetric Analysis by Means of the Thermobalance. Part XII.) By TAKASHI TASHIRO.

Determination of Elements of Halogen and Sulphur Groups. (Studies on Gravimetric Analysis by Means of the Thermobalance. Part XIII.) By KOJIRO MATSUURA.

On the Chemistry of Japanese Plants. IX Biochemical Study of Apples. By SHIGERU KOMATSU, SHINSAKU OZAWA and SHOZO TANAKA.

Thermodynamical Studies of Lithium Hydroxide and Lithium Chloride. By YUJI UETA.

The Relation between Kolbe's Reaction and the Hydrogen Ion Concentrations. IV. Electrolyses of Potassium Acetate and Ammonium Acetate in Dilute Solutions. By RYOICHI MATSUDA.

Electrolytic Oxidation of Arginine. (The Electrolytic Reactions of the Amino Acids and Related Compounds. III.) By YOSHITARO and TORAO TANABE.

Esters of Oleic and Elaidic Acid. Part I. By RYOSEI KOYAMA.

Studies on the Rare Earths. Second Report. On the Thermal Decomposition of Some Rare Earth Compounds. (Studies on Gravimetric Analysis by Means of the Thermobalance. Part XIV.) By TAKIO KATO.

Forthcoming Events.

FRIDAY, JANUARY 15.

INSTITUTE OF METALS. *Sheffield Section.* University Sheffield, at 7.30 p.m. "Stresses in Metals," by A. Wragg.

S.C.I. *South Wales Section.* Joint meeting with the South Wales Section of the Institute of Chemistry. The National Oil Refineries, Skewen, at 7 p.m. "Liquid Fuels, To-day and To-morrow," by Dr. A. E. Dunstan. Lecture will be preceded by visit to the National Oil Refineries.

PHYSICAL SOCIETY. Imperial College of Science, South Kensington, at 5 p.m.

SOCIETY OF DYERS AND COLOURISTS. *Manchester Section.* College of Technology, Manchester, at 7 p.m. "Beam Dyeing with Vat Colours," by J. R. S. Goodall.

THURSDAY, JANUARY 21.

S.C.I. *Ottawa Section.* At 8.15 p.m. Joint meeting with Canadian Institute of Chemistry, Ottawa Branch. Lecture by Prof. E. W. R. Steacie.

INSTITUTE OF METALS. *Birmingham Section.* Chamber of Commerce, Birmingham, at 7 p.m. "Electric Welding of Non-Ferrous Alloys," by A. Burstall.

Chemical Society. Ordinary Scientific Meeting. Burlington House, Piccadilly, W.1., at 8 p.m.

FRIDAY, JANUARY 22.

S.C.I. *South Wales Section.* Joint meeting with the South Wales Section of the Institute of Chemistry. Technical College, Cardiff, at 7.30 p.m. "Accurate Volume and Weight Measurements," by A. J. Cruise.

INSTITUTE OF CHEMISTRY. *South Wales Section.* Joint meeting with the South Wales Section of the Society of Chemical Industry. (See above.)

S.C.I. *Liverpool Section.* Joint meeting with the Manchester Section. University, Liverpool, at 6 p.m. Jubilee Memorial Lecture : "Liquid Fuels, To-day and To-morrow," by Dr. A. E. Dunstan. Visit to the Ocean Petroleum Installation of the British Petroleum Co., Ellesmere Port.

S.C.I. *Manchester Section.* Joint meeting with the Liverpool Section. (See above.)

Publications Received.

Examination of Water: Chemical and Bacteriological. By W. P. Mason. 6th Edition, revised by A. M. Buswell. Pp. ix+224. New York : J. Wiley and Sons; London : Chapman and Hall. 1931. 18s.

Chemical Embryology. By J. Needham, M.A., Ph.D. Vol. I-III. Pp. 613, 614-1,253, 1,254-2,021. Cambridge University Press, Ltd. 1931. 3 Volumes, £5 5s.

Analytical Chemistry. A Text-Book for a one-year combination course in Qualitatibe Analysis. By J. C. Ware, Ph.D. Pp. xiv+462. New York : J. Wiley and Sons; London : Chapman and Hall. 1931. 22s. 3d.

Outlines of Theoretical Chemistry. By F. H. Getman, Ph.D. 5th Edition, revised and largely rewritten by F. Daniels. Pp. ix+643. New York : J. Wiley and Sons; London : Chapman and Hall. 1931. 22s. 3d.

Inorganic Chemistry. By T. W. Lowry, C.B.E., M.A., D.Sc., F.R.S. 2nd Edition Pp. xiv+1,101. London : Macmillan and Co. 1931. 25s.

Essentials of Bacteriological Technique. By R. F. Hunwicke, B.Sc., With an introduction by W. G. Savage, B.Sc. Pp. 108. London : Williams and Norgate, Ltd. 1931. 8s. 6d.

Chemistry, Life and Civilisation. By H. T. S. Britton, D.Sc., F.I.C. Pp. vi+248. London : Chapman and Hall. 1931. 10s. 6d.

Science in Action. By E. R. Weidlein and W. A. Hamor. Pp. xiii+310. London : McGraw Hill Publishing Co. 1931. 18s.

UNITED STATES DEPARTMENT OF THE INTERIOR.

Geology and Ore Deposits of the Goodsprings Quadrangle, Nevada. By D. F.

Hewitt. Professional Paper 162. Price $1.15.

The Significance of Geologic Conditions in Naval Petroleum Reserve No. 3, Wyoming. By W. T. Thom, Jun., and E. M. Speikker, with a section on the Waters of the Salt Creek-Teapot Dome Uplift. By Herman Stabler. Professional Paper 163. Price 1.25.

Geology of the Eastern Part of Santa Monica Mountains, Los Angeles County, California. By H. W. Hoots. Professional Paper 165-C. Price 75 Cents.

Surface Water Supply of the United States, 1928. Part V, Hudson Bay and Upper Mississippi River Basins, Water Supply. By N. C. Grover, Chief Hydraulic Engineer. Water Supply Paper 665. Price 20 Cents.

Part VIII. Western Gulf of Mexico Basins. By N. C. Grover, Chief Hydraulic Engineer. Water Supply Paper 668. Price 20 Cents.

Part XII. North Pacific Slope Drainage Basins. B. Snake River Basin. By N. C. Grover, Chief Hydraulic Engineer. Water Supply Paper 673. Price 25 Cents.

Part XII. North Pacific Slope Drainage Basins. C. Pacific Slope Basins in Oregon and Lower Columbia River Basins. By N. C. Grover, Chief Hydraulic Engineer. Water Supply Paper 674. Price 25 Cents.

Part XI. Pacific Slope Basins in California. By N. C. Grover, Chief Hydraulic Engineer. Water Supply Paper 691. Price 45 Cents.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by permission of the Controller of H.M. Stationery Office and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., price 1/- weekly (annual subscription, £2 10s.).

Latest Patent Applications.

35,368.—Dreyfus, H.—Manufacture, etc., of organic compounds. December 22.

35,369.—Dreyfus, H. — Manufacture of oxygenated organic compounds. December 22.

35,370.—Dreyfus, H. — Manufacture of aliphatic compounds. December 22.

35,378.—Dreyfus, H. — Manufacture of organic oxy compounds. December 22.

35,716.—Freedland, J. — Manufacture of pure carbon. December 24.

Specifications Published.

363,347.—Crundall, S. F. W., Llewellyn, I. P., and Spence and Sons, Ltd., P. —Preparation of calcium sulphate.

363,423.—Carpmael, A. (I. G. Farbenindustrie Akt.-Ges.).—Process for the manufacture of alkali chromates.

363,526.—Akt.-Ges Fur Stickstoff-Dunger. —Manufacture of shaped calcium oxide.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

Group Abridgments can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., either sheet by sheet as issued on payment of a subscription of 5s. per Group Volume or in bound volumes, price 2s. each.

357,528.—Alkyl chlorides. Triggs, W. W., 57, Lincoln's Inn Fields, London. —Du Pont de Nemours and Co., E. Wilmington, Delaware, U.S.A.

Alkyl chlorides are obtained by bringing a vapour mixture consisting of one molecular proportion of an alcohol of not more than three carbon atoms and at least one molecular proportion of hydrogen chloride into contact with an aqueous solution of a metal chloride catalyst such as zinc chloride or ferric chloride, at a temperature high enough to effect the reaction and drive off continuously the water formed, so that the water content of the solution remains substantially constant and the solution maintains it liquid phase at ordinary temperatures. The vapour mixture, preferably containing excess of hydrogen chloride, may be produced by heating dilute sulphuric acid with sodium chloride and alcohol. The vapours pass to a second reaction vessel containing the metal chloride solution, preferably maintained at a temperature of from about 110 to 150° C. The vapours leaving the second vessel are washed with water and concentrated sulphuric acid to free them from hydrogen chloride and ether, and are then condensed. An example is given.

THE CHEMICAL NEWS

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Communications appertaining to Advertisements to be addressed to the Advertisement Manager
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THE ACTION OF SULPHUR DIOXIDE ON SODIUM CHLORIDE.

By Edward J. Weeks, M.A., M.Sc., Ph.D.

In two previous papers (Weeks, *Chemical News*, 1931, p. 50 and Weeks and Houslop, *Chemical News*, 1931, p. 279), it has been shown that sulphur dioxide acts as an oxidising agent if passed over heated calcium carbonate, giving the sulphate and sulphur. It was also shown that this fact had an important bearing on the problem of sulphur deposits. During the investigation it was noticed that sulphur deposits are very often found in conjunction with deposits of sodium chloride. It was, therefore decided to investigate more fully the action action of sulphur dioxide on salt.

Some pure precipitated salt was weighed in a porcelain boat and pure dry sulphur dioxide was passed over it whilst it was heated. The excess of sulphur dioxide was absorbed either in caustic potash or in water. The salt was found slowly to increase in weight. Qualitative examination of the substance left in the boat showed the presence of chloride, sulphur and sulphate. The sulphur was always deposited in the cooler parts of the tube. The water was boiled until free from any reducing action of potassium permanganate and was tben found to give both positive tests for sulphate and chloride. It was therefore assumed provisionally that the action followed the equation

$$2SO_2+2NaCl=Na_2SO_4+Cl_2+S$$

The chlorine on passing into the water oxidised the sulphur dioxide yielding a mixture of hydrochloric and sulphuric acids. In order to test this hypothesis the percentage increase in weight of the salt was used to find the percentage of sulphate in the final substance. The sulphate was also estimated by precepitation as barium sulphate and also by the increase in weight found on evaporating to dryness with sulphuric acid and weighing the resultant sulphate. The results given below were obtained on samples of salt which has been treated with sulphur dioxide for about 20 hours when constant weight had been obtained.

Theoretical percentage sulphate	67.6
Found by increase in weight ...	20
,, ,, estimation as $BaSO_4$	23.1
,, ,, conversion to Na_2SO_4	[illegible]

It was obvious from these results that there was some reason for the constancy of weight before total conversion.

During the experiment it was also noticed that some sulphur trioxide was formed when the sulphur dioxide acted on salt and also that when the excess of sulphur dioxide was absorbed in caustic potash a yellow liquid was formed. The cause of this yellow solution has not yet been found.

In order to accelerate the reaction dry oxygen was admitted with the sulphur dioxide. Fumes of sulphur trioxide were immeditely obtained and a deposit of sulphur was deposited on the cooler parts of the tube. Qualitative tests showed the presence of sulphate and chloride in the substance left in the boat and sulphuric acid and hydrochloric acid in the water. The actions taking place were assumed therefore to follow the the equation

$$3SO_2+2O_2+2NaCl=Na_2SO_4+Cl_2+2SO_3$$

The sulphur deposit probably arises from the interaction of the sulphur dioxide and salt as previously described.

C. Schultz Sellack reported that sulphur trioxide is absorbed by sodium chloride to form a syrupy mass which becomes crystalline. He ascribed the formula $NaCl\ 4SO_3$ to this substance. Since we have both salt and sulphur trioxide present in this case we should expect to find this substances $NaCl\ 4SO_3$. The sodium chloride was found to fuse during the reaction with the production of a hard glassy solid. This solid was therefore analysed to see if the product of C. Schultz Sellack had been obtained or if it were more in the nature of sulphalite $3Na_2SO_4 2NaCl$, a rare crystalline mineral occuring in the borax lake district. It should be noticed here that the fact that sulphur dioxide has no effect on sodium sulphate at a red heat (Berthelot, *Compt. Rendu*, 96, 298, 1883) has been confirmed.

In order to test the crystalline mass left the percentages of sulphate and chloride were estimated in various ways. The means given below were for four analyses each.

1. All chloride converted into sulphate by ignition with sulphuric acid.

   Chloride mean 31.8 per cent.
   Sulphate ,, 82 ,, ,,

2. Estimation of chloride by conversion to silver chloride.

   Mean [illegible] per cent.

3. Estimation of sulphate as barium sulphate.

Mean 33.8 per cent.

No reliable results were obtained by estimation of increase in weight as on fusion it was found that the mass of salt swelled up and some of the substance was invariably lost.

Mean chloride, all methods 36.5 per cent.
,, sulphate ,, ,, 33 ,, ,,

Assuming the substance to have the formula x Na_2SO_4 y NaCl we have

$$\frac{96x}{35.5y} = \frac{SO_4}{Cl} = \frac{33}{36.5}$$

$$\therefore \quad x/y = \frac{1}{2.991} \doteqdot \frac{1}{3}$$

We may therefore assume the formula

$Na_2SO_4 3NaCl$

This would give sulphate 30.2 per cent. and chloride 33.5 per cent. which agrees well with the values found.

Further investigations into this substance are being made and also the bearing of this work on sulphur deposits is being examined.

A complete summary of the various reactions which appear to take place is given in equation form below.

$$2\ NaCl + 2SO_2 = Na_2SO_4 + Cl_2 + S$$
$$2NaCl + SO_2 + O_2 = Na_2SO_4 + Cl_2$$
$$Na_2SO_4 + 3NaCl = Na_2SO_4 3NaCl$$
$$2SO_2 + O_2 = 2SO_3$$
$$3SO_2 = 2SO_3 + S$$
$$2S + Cl_2 = S_2Cl_2$$

THE SEARCH FOR ELEMENT 87.

It appears that serious competition is taking place in the search for element 87 (Eka-Cæsium), an element which has proved as elusive as the Scarlet Pimpernel of fiction. Professor Gustave A. Aartovaara, of Helsingfors, Finland, is the third and latest competitor in the race to identify this elusive metallic element. Professor Aartovaara, some while ago sent a sample of his preparation (obviously a compound, as owing to the element's apparent volatility it could not be completely isolated in a pure state) to be examined by Dr. W. F. Meggers of the U.S. Bureau of Standards, whose report on the optical spectrum has just been announced. This announcement follows upon the rival claim of Professor J. Papish, of Cornell University (whose claim was published in the *Chemical News*, 1931, Vol. 143, 3732, page 270.) Papish declares that he found the missing alkali in a rare mineral, samarskite. About a year ago, Professor F. Allison of the Alabama Polytechnic Institute, announced the discovery of the element, by the use of a magneto-optic method of his own invention. According to Dr. Meggers, no specific evidence that the Finnish scientist's preparation contains 87 is available, though the spectra of all the related alkali metals, including potassium and sodium have been found, Meggers declares that the crucial lines in the optical spectrum will lie in the infra-red region where, of course, investigation is somewhat troublesome. Only the X-ray spectrum, used by Papish and his colleagues, will definitely decide the question, although it is doubtful if Professor Papish has given convincing measurements which actually prove the existence of Eka-Cæsium in his extract.

A point in favour of Professor Aartovaara's substance as a sample likely to contain the element, is that it is radio-active. This is to be expected in view of the element's close proximity to radium in the periodic table, although several well-known scientists stated last year in unequivocal terms their doubts as to the element's radio-activity. Neither Allison's, nor Papish's samples are radio-active.

The German chemist, Ebler, it will be remembered, as far back as 1908, examined a radio-active alkali solution for the missing element, but was unable to find it. The activity, in this case, was due to a trace of a known radio-active element. Like the alchemist's dream of yore, hopes have been entertained by investigators that 87 would be found in radioactive alkali solutions, and like the alchemist, their dreams have remained unfulfilled. Yet here is a different quest from that of the alchemist, and it will be found—by whom—who can tell?

A distressing feature of the Aartovaara claim is the threat of blindness which is hanging over the claimant, and it is arousing grave anxiety in the minds of Dr. Meggers and his colleagues in the Bureau of Standards. The injury was occasioned by glass splinters which severely injured his eyes as a result of an explosion of his apparatus. The explosion is believed to have been due to the action of the radioactive rays on the solution.

H.W.B.R.

The Chemistry of the Conversation of Algæ into Bitumen and Petroleum and of the Fucosite-Petroleum Cycle *

By J. E. HACKFORD, B.Sc., F.I.C.
Member of The Institution of Petroleum Technologists.

INTRODUCTION.

Among the several theories at present existent as to the origin of petroleum oils, one of general acceptance is that some types of petroleum have been derived from the decomposition of marine vegetation; but the mechanism of the chemical reactions involved in this metamorphosis have not hitherto been fully investigated.

No facts supporting the suggestion that oils are produced by the natural decomposition of algæ have yet been brought to light, nor indeed, has oil been produced from algæ in a manner in any way similar to processes, or under conditions resembling, those obtaining in nature.

The author has been able to establish :—

(1) The formation of oil from algæ by processes similar to those obtaining in nature.

(2) The presence of the decomposition products of algæ in both naturally occurring oils as obtained from wells, and also from seepage oils and bituminous deposits.

(3) The reconversion of oils, various oil seepages, and some seepage products into bodies closely resembling, and in some instances identical with the constituents and decomposition products of algæ.

(4) The formation of oils and bitumens from sugars.

(5) The reconversion of oils into bodies resembling bitumens, which upon hydrolysis yield sugars.

While the above work supports the algal theory of the origin of some classes of petroleum, the data obtained shows that oil and bitumen are in the main produced from the *sugars resultant upon the hydrolysis* of algæ.

On this account it may be advisable to rename the vegetal theory, and to call it "The Carbohydrate Theory of the Origin of Oil."

DEFINITIONS.

The term "Protobitumen," as employed herein, is a chemical definition, and must tion as accepted by the International Committee for the Standardisation of Nomenclature and Tests of Road Materials, and by the American Society for Testing Materials. This reads :—

"*Bitumens.*—Mixtures of hydrocarbons of natural or pyrogenous origin or combinations of both (frequently accompanied by their non-metallic derivatives) which can be gaseous, liquid, semi-solid or solid, and which are completely soluble in carbon disulphide."

Protobitumen is a partially reduced† carbohydrate which, upon further or total reduction, yields oil. Conversely, protobitumen is a partially reduced carbohydrate formed by the oxidation of oil. Naturally occurring protobitumens may contain other decomposition products of algæ, such as metallic salts and organic derivatives of sulphur and nitrogen, according to the type of the parent algæ.

It is possible, and indeed probable, that the chemical definition of protobitumen as given above will be found to apply also to bitumens, which may have been derived from other sources. In the meantime, however, it is limited to the bituminous material derived from algæ, and to the oxidised products of the oils obtained from them. This procedure is adopted because there is at present no real chemical evidence to justify oils and bitumens of animal or other origins being included.

Oil.—The term oil as used herein denotes a mixture of hydrocarbon oils, and such alcohols, ketones, aldehydes, carboxylic and poly-hydroxy-carboxylic acids which yield hydrocarbons upon reduction. These latter compounds are found in some of the well oils and seepage oils herein discussed.

* Paper read before the Institution of Petroleum Technologists on 12 January, 1932.

† By *reduction* is understood the treatment of a substance in such wise that the percentage of hydrogen in the end product is greater than that in the original com-

Asphaltenes.—That portion of bitumen which is soluble in carbon disulphide, but insoluble in ethyl ether.

Kerotenes.—That portion of bitumen or protobitumen which is insoluble in carbon disulphide.

Kerols.—That portion of the kerotenes which is soluble in both chloroform and pyridine.

Keroles.—That portion of the kerotenes which is soluble in pyridine, but insoluble in chloroform.

Kerenes.—That portion of the kerotenes which is insoluble in organic solvents.

Kerites.—Naturally occurring bitumens and protobitumens composed appreciably or wholly of kerotenes.

Algarose is chemically pure protobitumen prepared by the acid hydrolysis of sugars. It reduces Fehling solution, and is free from metallic salts and organic derivatives of sulphur and nitrogen.

Algarites are naturally occurring protobitumens, composed chiefly of algarose, together with the metallic salts, sulphur, and the nitrogenous organic derivatives simultaneously formed during the acid hydrolysis of algæ.

It occurs in nature as a natural bitumen, or highly bituminous shale in the form of McKittrite, and is capable of yielding oil by reduction.

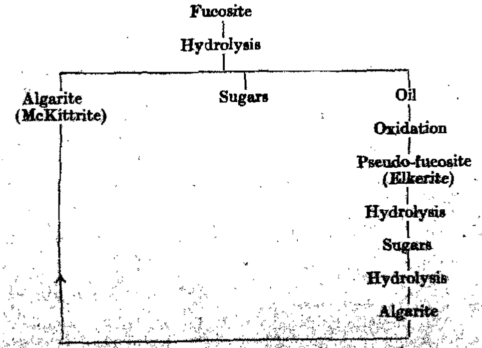
Fucose is the sugar obtained by hydrolising the polymer fucosan, which is a component of the cell wall of marine algæ.‡

Fucosite is a naturally occurring mineral, which is composed of the lesser water-soluble portions of seaweed. The structure has almost been entirely lost by the action of bacteria and oxygen. It has been called "Fucosite" because it contains a sugar complex which is liberated by either alkaline or acid hydrolysis. During the latter process oil and algarose are formed. In the samples hereinafter quoted the fucosite mainly consists of a fucose pentosan.

Elkerite and pseudo-fucosites.—Elkerite is a naturally occurring bitumen formed by the slow oxidation of oil. It is a fucose pentosan—hence the class term "pseudo-fucosite" to distinguish it from the seaweed complex, Fucosite. It is built up from oil, cf. algarite, which is a decomposition product of algæ.

THE FUCOSITES OR THE SUGAR-FORMING BITUMENS.

The following diagram illustrates the inter-relationship between the various types of sugar-forming bitumens :—



‡ "Dictionary of Applied Chemistry," Thorpe, 1912, vol. I., 644.

Fucosite	Hydrolysis →	Algarite
Oil	Oxidation →	Pseudo-fucosite (Elkerite)
Pseudo-fucosite	Hydrolysis →	Sugars
Pure sugars	Hydrolysis →	Algarose
Impure sugars ex fucosite	Hydrolysis →	Algarite

SECTION I.

THE FORMATION OF OIL BY THE NATURAL DECOMPOSITION OF ALGÆ.

The development of the Algal theory.—The Algal theory of the derivation of petroleum as distinct from the general term "vegetable" theory can be said at the present date to have been only a considered possibility. Both of these theories have been obscured by the "inorganic" and the "animal remains" hypotheses, which may be criticised as being supported by very meagre experimental chemical evidence.

In the earliest references[1] both land and marine plants were grouped together as "plant" remains, and together with "animal remains" were considered as being the matter from which oil originated.

The vegetable theory was overshadowed in 1888 by Engler's researches on menhaden oil.[2] By the distillation of this oil at a temperature commencing at 320° C. under a pressure of 10 atmospheres and ending at a temperature of 400° C. at a pressure of 4 atmospheres, Engler obtained about 60 per cent. of distillate of specific gravity 0.8105, and about 8.9 per cent. of gas, etc. The distillate was found to contain paraffins, such as pentane, hexane, normal and secondary heptane, and normal octane and nonane. These results were later confirmed by Redwood, and thus the Engler Theory of the derivation of oil from animal remains was founded. This was enlarged and developed by Höfer,[3] and for a time was generally accepted.

It was not long, however, before doubts began to arise as to the universal applicability of this theory, and in particular Orton,[4] upon the basis of his observations made in 1886, insisted that the production of oil must have occurred in nature at temperatures below 200° C.

In 1894 Porter[5] pointed out that the gases obtained during the distillation of menhaden oil by Engler differed from naturally occurring petroleum gases, inasmuch as they contained 25–38 per cent. of carbon monoxide, and a considerable proportion of olefines, while the percentage of saturated paraffinic gases was small. Porter then pointed out that, by the natural decomposition of marine vegetation under water, i.e., at low temperatures, gases are evolved similar in composition to natural gases.

Founded on this piece of direct evidence, Porter supports the marine vegetation theory; and in the same year Witt[6] showed that the waxy matter secreted by diatoms may contribute to the production of petroleum.

Confirmatory evidence of the production of oil from algæ was given by the author[7] in 1922, who showed the similarity of the metallic contents of algæ and of oil, and commented upon the fact that iodine, bromine, phosphorus, and ammonium salts were also common. The low nitrogen content of oil followed from the low nitrogen content of the algæ, whilst the low phenol and furfural content of the oil was attributed to the small percentage of cellulose present in algæ.

[1] Henkel, 1725.

[2] *Ber. deut. chem. Gesselschaft*, 1888, *21*, 1816; 1889, *22*, 592. See also Engler and Seidner, *Dinglers polytech. Jour.*, 1889, *271*, 515.

[3] Höfer, "Das Erdol," p. 118.

[4] Orton, "Prelim. Report on Petrol. and Imflamm. Gas," 1886, p. 11.

[5] Porter, *Am. Chem. Jour.*, 1894, *16*, 406.

[6] See Redwood, "Treatise on Petroleum," Vol. I., 4th ed., p. 359.

[7] Hackford, *J.I.P.T.*, 1922, *8*, 197.

Ramsay[8] in 1924 raised an objection to the organic theory in the following form :—" A further argument against the organic theory is the almost entire absence of the nitrogenous and oxygenated compounds which are associated with the decomposition of animal and vegetable matter, and which usually break into compounds dissimilar from petroleum." It is dubious whether this objection can be upheld, as the nitrogenous content of organic matter is largely transformed into water-soluble ammonium salts, while the remainder is converted, *inter alia*, into tertiary amines, which are soluble in oil. Traces of ammonium salts[9] are often found in conjunction with crude oil, while tertiary amines are well-known constituents.[10].

It is also questionable whether Ramsey's objection to the almost entire absence of oxygenated compounds can be allowed. We know that the percentage of oxygen by weight would be small, and therefore difficult to determine accurately, and we also know that vegetation is deprived of its oxygen content by bacterial action, etc.

Taylor[11] proved the suggestion, first made by Radzisewski,[12] that organic matter under sodium clays was decomposed by anærobic bacterial action with the production of gases similar to naturally occurring petroleum gases. The demonstration of the decomposition of sugars under these conditions is of considerable importance, inasmuch as these constitute a considerable proportion of the decomposition products of marine vegetation. He further suggests that " all shales overlying oil-bearing strata have undergone base exchange and bydrolysis," and that " the medium produced by hydrolysis favours the bacterial action under alkaline anærobic conditions, with the formation of gases similar in composition to natural gas."

Modern opinions endorse Taylor's views; Trask[13] states that " anærobic bacteria, because of their tendency to decrease the nitrogen and oxygen of organic matter on which they feed, probably produce compounds more similar in composition to petroleum than the original organic matter that was deposited by the sediments. Their action, therefore, may facilitate the generation of petroleum by purely chemical means." Thayer, and also Brooks, generally confirm these views, but Hammer[13] states that : " bacteria, by removing oxygen and nitrogen from organic matter, form compounds more closely related to petroleum than the original organic material, thus presumably facilitating the generation of petroleum by purely chemical means." Aerobic micro-organisms in the sea water and the upper layers of the sediments may form amino and lower fatty acids from more complex organic material. Anærobic bacteria characterise all but the surface layers of the deposits, and remove oxygen, nitrogen, and sulphur from the organic matter in the sediments. Some anærobic bacteria form methane, *but none is known to generate hydrocarbons that characterise petroleum.*

In a contribution to a recent paper by D. White on the subject of " Time versus Temperature in Petroleum Generation," Thrask[13a] extends the conclusions based on Maier and Zimmerly's work on oil-shale, by giving data of his own researches on the effect of heat on modern organic muds. He gives quantitative figures of the amount of organic matter converted into bitumen at temperatures ranging from 280° to 389° C. He concludes that the heat due to blanketing in the earth's crust probably produces bitumen from the organic contents of the sediments, and suggests *that the formation of bitumen is perhaps an intermediate step in the generation of petroleum.*

The Chemical Properties of Algæ.—Algæ are plants which absorb their mineral constituents by their whole surface from the waters in which they live. The same species of algæ may, therefore, contain different metals dependent upon the nature of the waters in which they exist. Seaweeds show many peculiarities not shared by terrestrial plants. The presence of a multiplicity of elements in the mineral constituents, of ethereal sulphates in the cell wall constituents, the lesser amount of cellulose, the presence of alginic acid, the common occur-

[8] Ramsay, *J.I.P.T.*, 1924, *10*, 88.

[9] Mrazac, *Petr. Times*, 1922, *8*, 840; and Palmer, *Econ. Geol.*, 1922, *17*, 100.

[10] Maybery, *Econ. Geol.*, 000, *11*, 521-527.

[11] Taylor, *J.I.P.T.*, 1928, *14*, 825-840.

[12] Radzisewski, *Arch. Pharm.*, 1878, *3*, 455-459.

[13] Thrask, Thayer, Brooks, Hammer; see 16th Annual Meeting of Amer. Assoc. of Petr. Geol., 1931.

rence of mannitol, the presence of obscure carbohydrates such as laminarin indicate a metabolism differing from that of the normal terrestrial plant.

The predominating mineral is calcium, which exists in quantities of from 17 per cent. in *F. seratus* to 52 per cent. in the roots of *L. hyperboria* (calculated as calcium sulphate upon the dried material).

Many other metals and non-metals are present, and during this investigation several have been identified whose presence has not previously been recorded.

Calcium salts.—The calcium salts appear to be present partly as calcium sulphate and partly in organic combination.

Haas (1921)[14] found that *chondrus crispus* yielded an ash rich in calcium sulphate, even after prolonged dialysis, and assumed the existence of some form of masked sulphate such as an ethereal sulphate of the type represented by the formula

$$R<\begin{matrix} O.SO_2.O \\ O.SO_2.O \end{matrix}>Ca$$

Chemical evidence for the correctness of this assumption was furnished by the fact that the masked sulphate could be converted into the ionised sulphate by hydrolysis. The ethereal sulphates are widely distributed, and have been identified in the following rhodophyceæ and phæophyceæ; *ceramium rubrum, delasseria sanguinea, delesseria alata, polysiphonia fastigiata, plumaria elegans, ascophyllum nodosum,* and *laminaria digitata.*

Neuberg and Ohle[15] in 1921 established the presence of the ethereal sulphate grouping in agar, the extract of a species of gelidium.

In the case of *chondras*, the average molecular weight of the aqueous extract was 1000.[16]. The proof of the existence of an ethereal sulphate depended on the fact that the percentage of sulphate contained in the hydrolysed solution of the hot extract was just twice that contained in the ash, from which it is clear that, of the two molecular proportions of sulphate here given, only the one combined with the calcium would be found in the ash, the other in the form of free sulphuric acid being lost during incineration.

In the case of ceramium rubrum the following figures are given :—

Ash in crude weed	13.88%
SO_4 in above ash	15.63%
SO_4 in weed by hydrolysis ...	4.13%
SO_4 in weed by incineration...	2.17%

The following equation illustrates the reaction :—

$$R<\begin{matrix} O.SO_2.O \\ O.SO_2.O \end{matrix}>Ca + 2H_2O = R<\begin{matrix} OH \\ OH \end{matrix} + CaSO_2 + H_2SO_4$$

Sodium, potassium, ammonium, and phosphorus ethereal salts have also been identified. Haas[16] states that evidence of phosphoric acid in organic combination has been obtained in the case of chondrus.

Bird and Haas[17] in 1931 made an attempt to elucidate the nature of the cell wall constituents of the laminariaceæ known as fucoidin and alginic acid. The former has been shown to be the calcium salt of a sulphuric ester of a non-reducing polymerised uronic acid complex combined with a methyl pentosan, since it yields on hydrolysis sulphate ions and methyl pentosan fucose.

Alginic acid is a polymerised form of manuronic acid and contains no pentosan or methyl-pentosan groupings. These facts emphasise the distinctive metabolism of the brown algæ, which appears to be founded upon a mannose, rather than a glucose basis,—as is shown by the occurrence of mannitol and mannitan,[18] and the apparent absence of glucose in any appreciable amount. Hoagland and Lieb[19] state that in the carbohydrates of macrocystis pyrifera and iridæa laminarioides the acid precipitate complex known as "algin," yielded a pentazone closely resembling l-xylosazone. In the alcohol insoluble carbohydrate fraction (which are the salts of the calcium sulphonic esters) of macrocystis, a methyl

[13a] Thrask, *Bull. Amer. Assoc. Petr. Geol.*, 1931, *15*, 83-84.

[14] Haas, *J. Biol. Chem.*

[15] Neuberg and Ohle, *Biochem. Z.*, *125*, p. 311.

[16] Haas and Wells, *J. Biol. Chem.*, 1928, *117*, 698 *et seq.*

[17] Bird and Haas, *J. Biol. Chem.*, 1931.

[18] Haas and Hill, *J. Biol. Chem.*, 1929.

[19] Hoagland and Lieb, *J. Biol. Chem.*, 1915, *23*, 287-297.

pentose having the properties of fucose is present; a similar fraction from iridæa yielded only galactose.

Sugars.—Sugars other than the mannose and galactose mentioned have been identified among the hydrolytic products of decomposition of algæ. Bente, 1785, 1786, found levulinic acid, and also a sugar showing little or no optical activity in *chondrus crispus*. Hardicke, Bauer and Tollens (1867) established in carragen mucilage the presence of fructose and calculated that it contained 28 per cent. of galactose. They suggested that it might be present under the form of raffinose. Sebor (1900) confirmed the presence of fructose and galactose and showed small quantities of pentosan, and showed that raffinose was absent. He also found evidences of the presence of glucose. Wells[20] confirms the presence of pentosan.

Nitrogen Compounds.—Nitrogen exists in algæ to the extent of 1.485 per cent. in the case of *chondrus crispus*, and 4.65 per cent. in the case of *porphyralacinata*, both calculated on the dry matter.

Russel-Wells[21] showed that some of the nitrogen existed in the form of an ammonium ethereal salt of the type

$$R.O.SO_2.ONH_4$$

Instances are given in the experimental section of this paper that tertiary amines and ammonium salts are formed upon acid hydrolysis.

Hoagland[22] states that of the total nitrogen of the kelps he examined, from one-third to one-fifth was soluble in water, and about the same proportion was found by Stutzer's method to be in the form of non-protein nitrogen.

Stewart[23] finds that the nitrogen of *nereocystis luetkeana* is readily converted into ammonia when mixed with soil, whilst that of *pelagophycus* is less readily changed. *Macrocystis pyrifera* changes very slowly in the soil, especially when it has been dried.

Lafar[24] states that indole

$$C_6H_4 < \begin{matrix} CH \\ NH \end{matrix} > CH$$

and Brieger, that B-methyl indole or skatole, together with phenol (Bauman), ortho-cresol and paracresol (Bauman' and Brieger) are present in putrifying albuminoids. Leucine, lyrosine and valeric acid are also found.

$$\underset{\text{Leucine.}}{CH_3.CH_2.CH_2CH_2CH.NH_2.COOH} + 2H_2O$$
$$= \underset{\text{Valeric acid.}}{(CH_3)_2 = CH.CH_2.COOH} + H_2O + CO_2 + NH_3$$

Cellulose.—It is thought that the cellulosic contents of algæ give rise upon decomposition to furfural and phenols, the presence of which have been noted by Haas.

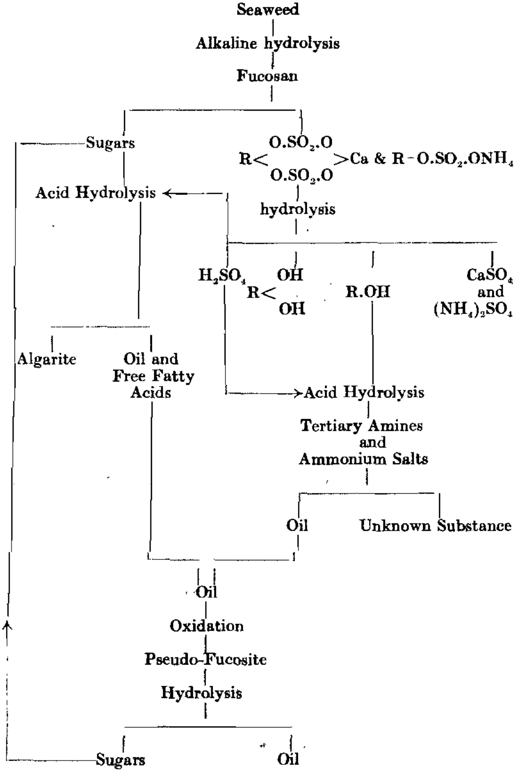
Norman[25] states that there is definite evidence for the production of some intermediary substance which yields furfural. It is probably that this is produced transitionally in the degradation of cellulose, although there is scanty support for this theory.

Nearly all the iodine present in seaweed (Okuda and Eto[26]) is in organic combination. The greater part of it is in a form soluble in water, strong alcohol, dilute alkalis or acids. It is not a protein compound. Concentrated solutions of sulphuric acid and sodium hydroxide decompose it completely. Decomposition is also brought about by micro-organisms, but there is no enzyme in the plant to effect this.

It occurred to the author that organic decomposition of an alkaline solution of seaweed by the action of anærobic bacteria might take place in media other than the alkaline clays suggested by Taylor. It appeared to him that the process was essentially one of hydrolysis, in which the bacteria firstly hydrolysed the fucosan or organic matter of somewhat similar chemical constitution, forming sugars—and that by further action the sugars broke down and gave rise to methane as recorded. It was found that an aqueous extract of algæ (*laminaria*) possessed an alkaline reaction. Upon exposure to the atmosphere a growth (*cladothrix dichotoma*) formed which acted

[20] *J. Biol. Chem.*, 1922, *16*, 584.
[21] J. Biol. Chem., 1922, 16.
[22] *J. Agric. Research*, 1915, 4, 39-58.
[23] *J. Agric. Research*, 1915, 4, 21-37.
[24] "Technical Mycology," Vol. I., p. 291.
[25] *J. Biol. Chem.*, 1929, *23*, p. 1884.
[26] *J. Coll. Agric. Imp. Univ. Tokyo*, 1816, 5, 341-358.

THE HYDROLYSIS OF SEAWEED.



pon the calcium salts of the ethereal sulhonic acids present, decomposing them ith the precipitation of calcium sulphate 1 the form of anhydrite. At the same time he nitrogen compounds were decomposed ith the formation of tertiary amines and mmonium salts. After three or four days he aqueous seaweed extract became trongly acid, due to the formation of free sulphuric acid. It was also observed that by blowing the aqueous extract with air for some time that a similar kind of reaction took place.

Assuming that in nature hydrolysis takes place over a long period of time, the aqueous extract of seaweed was submitted to prolonged acid hydrolysis. (Acid hydrolysis was chosen because of the formation of free

sulphuric acid by the *cladothrix dichotoma* and also by oxidation.) Both oil and a bituminous product were formed during acid hydrolysis of the aqueous extract of algæ, but not during alkaline hydrolysis. During the acid hydrolysis, the calcium salts of the sulphonic esters were decomposed with the precipitation of calcium sulphate, and the formation of tertiary amines, and oils similar in character to naturally occurring petroleum oils. These oils and the bituminous products formed the bulk of the decomposition products of the acid hydrolysis of the algæ. It was also found that sugars themselves were decomposed during acid hydrolysis, yielding both oil and protobitumen.

(To be continued.)

EXHIBITION OF SCIENTIFIC APPARATUS.

UNDER THE AUSPICES OF THE PHYSICAL AND OPTICAL SOCIETIES.

The twenty-second annual exhibition of instruments and apparatus held at the Imperial College of Science, South Kensington, on January 5-7 was well attended both by scientists and by the general public who were admitted on the last day. The exhibits were arranged into two sections, a manufacturers' section and a research and experimental section. The former was very well supported and covered the widest possible range of optical and electrical apparatus and new instruments. In the research section there were many interesting pieces of apparatus illustrating recent progress in physical research. Among the other noteworthy exhibits were photoelectric cells, argon glow tubes, a direct reading humidity meter operating on a wet and dry bulb thermometer, thermopiles, micromanometer, etc.

There were numerous demonstrations wrich were given repeatedly during the exhibition and three discourses were delivered. Mr. C. C. Paterson, F.Inst.P. gave an illustrated lecture on "Photocells: the Valves which operate by Light," on January 5; Mr. T. Smith, F.Inst.P., showed some "Photographic Shutters and their Properties," on January 6; and Sir O. Lodge, F.R.S., gave some "Reminiscenses," on January 7.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

APPLICATIONS FOR LICENCES IN DECEMBER, 1931.

The following statement relating to applications for licence under the Dyestuffs (Import Regulation) Act, 1920, made during December has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 434, of which 329 were from merchants or importers. To these should be added 19 cases outstanding on the 30 November, making a total for the month of 453. These were dealt with as follows :—

Granted—424 (of which 405 were dealt with within 7 days of receipt).

Referred to British makers of similar products—27 (of which 20 were dealt with within 7 days of receipt).

Outstanding on 31st December—2.

Of the total of 453 applications received, 453 or 94 per cent. were dealt with within 7 days of receipt.

ONTARIO NICKEL-COPPER INDUSTRY.

During the first nine months of this year, 1,374,725 tons of nickel-copper ore were raised from the mines, and 1,552,310 tons were smelted. Matte produced aggregated 82,627 tons with a nickel content of 67,168,687 lbs. and a copper content of 63,444,209 lbs. Exported matte totalled 24,395 tons, and there was treated in Ontario 64,739 tons. During the period, four mines were operated, three of which —the Creighton, Frood and Garson, are owned by the International Nickel Company of Canada, Ltd., and the Falconbridge mine of the Falconbridge Nickel Mines, Ltd. Ore raised during the period fell off by more than 16 per cent.

HOME-MADE CAUSTIC SODA APPEARS IN JAPAN.

A great sensation has been created in the rayon industry by the appearance of the home-made caustic soda which is sold at a very cheap rate, says the Yakugyo Shuho of Tokyo. Hitherto, the Japanese rayon manufacturers have been using caustic

soda imported by the Brunner Mond, while Soviet Russia also have begun inroads into the same field. Recently, the Nippon Soda Kogyo Kabushiki kaisha began producing caustic soda as a method of disposing of its soda ash, and is now selling it at a very cheap rate. It s believed that the Nippon Soda can supply the entire domestic demand so that there will be no need of importing any. However, many consumers have contracts made with the Brunner Mond so that they cannot buy the home-made caustic soda at a cheaper rate without violating the contracts.

Proceedings and Notices of Societies

THE PHYSICAL SOCIETY.

Friday, January 15, 1932.

The following papers were read :—

Some Thermomagnetic Effects in Nickel and Iron. By WILLIAM BAND, M.Sc., and SHIH-CHEN TAO (in title).

The paper relates to the production of an e.m.f. in nickel and iron wires by the simultaneous application of a longitudinal magnetising field and a temperature-gradient. This e.m.f. has been measured for various fields and temperatures.

The Electroscope Capacity Balance. By E. S. BROWN, D.Sc., A.C.G.I., University of Melbourne (in title).

Capacities of a few $\mu\mu F$ are measured by means of two electroscopes connected in series with a source of e.m.f. and shunted by variable condensers. The intersection of the gold-leaves lies on a straight line so long as the capacities of the condensers are equal. The unknown capacity is shunted upon one of the condensers which is then adjusted till the sum of the capacities is equal to the capacity of the remaining condenser.

On Periodic Movements of the Negative Glow in Discharge Tubes. By MISS W. A. LEYSHON, Ph.D.

An account is given of experiments designed to discover the cause of the jumping glow phenomenon in discharge tubes. It is shown that the effect is produced when traces of hydrocarbon vapour are present in the tube in addition to the filling gas (neon, in most of the experiments here described). Some effects of such traces of vapour on the characteristics are given.

It is suggested that the phenomenon of the jumping glow may be due to internal flashing at that part of the surface of the cathode which is not covered by negative glow. The flash may be caused by the electrical breakdown of a partially insulating hydrocarbon layer, as a result of the collection of positive ions, or by a surface chemical action occurring when the reaction-products of the discharge have reached a certain concentration at that surface. It is supposed that the electron emissivity of the surface is increased by the flash, and that the main glow jumps to the activated surface. The process is reversible and hence may be periodic. Observations connecting the periodic time of jumps with the current through the tube are in support of this explanation, as also are other experimental results described in the paper.

A Cathode-Ray Oscillographic Method of Measuring Inductance. By PROFESSOR G. I. FINCH, M.B.E., and R. W. SUTTON.

The voltage fluctuations across the condenser in a damped oscillatory circuit, comprising inductance, capacity and resistance, are recorded by means of a cathode-ray oscillograph. The following relationship is derived :

$$L = CV^2\{1+\lambda+(\tfrac{1}{2}+2/\pi^2)\lambda^2+(\tfrac{1}{6}+2\lambda^3/\pi^2)\lambda^3\}/i_0^2,$$

where L is the inductance, C the capacity, V the first peak voltage across C in a train of damped oscillations, i_0 the primary current through L at break of a charging circuit through L at break of a charging cir- oscillatory circuit. The measurement of V and λ from the oscillogram is discussed.

On the Measurement of Electrical Resistance in Terms of a Mutual Inductance and a Period. By H. R. NETTLETON, D.Sc., and F. H. LLEWELLYN.

It is shown that if the ratio α/a of the radii of the concentric circles forming a simple inductometer is 0.50607_8, the mutual inductance is so accurately proportional to the angle through which the turning coil is displaced that the rising deviation from a linear law is less than 5 parts in a million at 7° of deflection. If the outer circle is replaced by two twin circles which are separated symmetrically with regard to the turning coil, the ratio α/a must be increased to bring about a similar approach to linearity.

If a heavy dynamometer is constructed on this principle, then, over the range indicated, the deflecting couple is strictly pro-

portional to the current-products. Moreover if such a dynamometer be damped electrically, the damping-couple is accurately proportional to the velocity and, over a range of oscillation of 14°, we have a remarkably close approach to true damped simple harmonic motion.

It is shown that the resistance of the oscillator circuit is very accurately given by the expression

$$R = \frac{CM}{c}\left[\frac{\lambda T}{\pi^2+\lambda^2} - \frac{\lambda_0 T_0}{\pi^2+\lambda_0{}^2}\right],$$

where λ is the logarithmic decrement and T the period on closed circuit of the oscillator when a current C traverses the field coils, while λ_0 and T_0 correspond to open circuit and M is the mutual inductance between the oscillating coil and the field coils when the former is in the position of steady deflection due to the passage through it of a steady current c, in conjunction with the circuit C through the field coils. This expression eliminates quantities difficult to measure in Weber's method. Experimental tests are described. Tables of Legendre and other functions, which facilitate the calculation of mutual inductances of the nature here considered, are appended.

THE GEOLOGICAL SOCIETY OF LONDON.

December 16, 1931.

Prof. W. W. Watts, LL.D., Sc.D., F.R.S., Vice-President, in the Chair.

The following communcation was read:

The Tertiary Ring Complex of Slieve Gullion (Ireland). By James Ernest Richey, M.C., B.A.I., F.G.S., with petrological notes by Herbert Henry Thomas, M.A., Sc.D., F.R.S.

The tertiary intrusive complex of Slieve Gullion lies west of the Mourne Mountains and north-west of the Carlingford peninsula. Topographically, it consists of a ring of curving ridges and hills, 7 miles in diameter, which is bisected by a mountainous belt extending to the north-west. The ring and the North-West Belt mark the outcrops of a very simple ring-dyke complex and later Tertiary plutonics (not described in the present paper). The area was mapped by J. Nolan, F. W. Egan, and W. A. Traill of the Geological Survey over 60 years ago, and their work has now been extended by the Authors.

The Sleve Gullion Tertiary rocks are intruded around the western portion of the Newry Granite. This, in its composition and in its relations to Silurian country rocks, resembles the Lower Old Red Sandstone granites of the Southern Uplands of Scotland.

The Ring Complex forms a complete ring, except to the south-west, where it is broken through by the North-West Belt. It includes the following rocks, in order of age: (1) Lavas of olivine-basalt, basalt with felspar phenocrysts, and trachyte, associated with (2) agglomerates, chiefly formed of fragments of Newry Granite and lying in vents along the south-western part of the ring. These, the Forkill vents, are intruded by (3) an elongate vent-intrusion and an arcuate ring-dyke of porphyritic felsite. The remainder of the ring is constituted of (4) remarkable breccias, due largely to crushing and partly to explosion, associated with (5) an extensive ring-dyke of porphyritic granophyre, in part a double or triple intrusion. This ring-dyke is intruded to the north-west and south-east by masses belonging to the North-West Belt. The Ring Complex is perhaps entirely earlier than the North-West Belt.

The olivine-basalts are identical with the Hebridean plateau type, and predominate over the other lavas. All appear to be downslipped masses within the vents. The agglomerate-fragments consist of various other rocks in addition to granite, and are evidently well mixed together. They include locally all the Tertiary lava-types mentioned, as well as a glassy andesite. The felsite sometimes penetrates the agglomerates so intimately as to form a matrix for the fragments, as Nolan observed, and the vent-brecciation is ascribed to gases given off from the uprising felsite magma. Age-relations of the felsite and granophyre ring-dykes are proved at contacts. The crush-breccias include flinty crushrock, and the crushing affects the granite-wall as well as the granophyre ring-dyke itself. The brecciation is most intense around the north and west sides of the ring-dyke. It suggests movement of the central block enclosed by the ring-fissure, but no marked subsidence can be proved.

The almost exact coincidence of the ring-fissure with the margin of the western portion of the Newry Granite is perhaps the most remarkable feature of the Ring Complex. A local magma-reservoir underlying

the Tertiary complex would seem to owe its position to the Newry Granite. If so, the reservoir should perhaps be ascribed to crustal-subsidence rather than to crustal re-melting, since it was, mainly at least, filled with magma of normal Tertiary affinities.

Wednesday, January 13, 1932.

The following papers were read :—

The Geological Structure of the Eastern Mendips. By FRANCIS BRIAN AWBURN WELCH, B.Sc., Ph.D., F.G.S.

The area here termed the Eastern Mendips comprises the Beacon Hill pericline, the most southerly situated of the four echeloned Mendip periclines and that bordering the Radstock Coalfield. As in the other three cases, the structure is anticlinal with a steeply folded north limb : the core is formed of Old Red Sandstone and Silurian, the Avonian outcroppng on the flanks. The south limb is much concealed by Mesozoic strata, which also stretch across the eastern part of the area, so that the Avonian can only be seen in deep ravines.

The region can be divided into three parts—the eastern, the western, and the central. The western area is relatively simple in structure and calls for little comment, except that on the north limb the D_2 Subzone has been detected. The eastern area is extensively faulted along the southern limb, the limestones being thrust along the line of the K-shales against the Old Red Sandstone. The central area forms a great thrust-block bordered by two north-and-south tear-faults which run through Downhead on the west and Chantry on the east. The beds on the north limb show little signs of faulting, whilst the limestones of the south limb were apparently thrust northward over the K-shales. The result was the production of a gigantic overfold on the north side (resembling in shape a breaking wave) under which the Coal Measures were thrust. All that remains of this overfold, which was shattered by minor thrusting, are the inliers of Vobster and Luckington, which lie in a due north line between the two tear-faults.

The whole sequence of events appears to have been the northward drive of the east-and-west pericline against the southern "nose" of the Coal Measure basin (with a north-and-south axis). Maximum resistance was offered to this movement along the line of this axis, and in this line lies the Central Fault Block. Consequently, the Coal Measures to the west are little disturbed, except for slight overfolding which gradually increases eastwards and reaches a maximum between the two tear-faults.

Upper Devonian Fishes from New South Wales. By EDWIN SHERBON HILLS, Ph.D., M.Sc., D.I.C., F.G.S.

The paper deals with a small collection of Devonian fishes sent to Sir Arthur Woodward some years ago by the Geological Survey of New South Wales, and described by the Author at his suggestion and with the sanction of the Under-Secretary for Mines in Sydney.

The greater part of the material comes from Harvey's Range, north-north-east of Parkes, but there is a single specimen from the Jemalong Gap, another single specimen from the western flank of the Canoblas Mountains, and a few plates preserved in limestone from an unkown locality. The faunal lists are as follows :—

(*a*) Harvey's Range.

Heterostraci	*Phyllolepis sp.*
Ichthyodorulites ...	*Striacanthus sp.*
Antiarchi	*Bothriolepis sp.*
	Remigolepis sp. nov.
	Genera indet.
Crossopterygii ...	*Holoptychius sp.*
	Genera indet.

(*b*) Western flank of the Canoblas.

Antiarchi	*Bothrialepis sp.*

(*c*) Jemalong Gap.

Antiarchi	*Bothriolepis* (?) *sp.*

(*d*) Unknown provenance.

Antiarchi	*Bothrialepis sp.*
Heterostraci	*Phyllolepis sp.*

Remigolepis is a new genus lately erected by Stensiö to embrace remains found in East Greenland, and its presence in the collection was recognised by him. Not only does the present record of Upper Devonian fishes from New South Wales greatly extend the known range of these forms in south-eastern Australia, but also it affords valuable evidence for the correlation of the Devonian rocks of that district. It is suggested that the shallow marine deposits of the Lambian (Upper Devonian) Series may be, in the main, older than the continental deposits of that epoch, and that the Upper Devonian rocks of Victoria may be equivalent of only the top of the series as it is developed in New South Wales.

Notices of Books.

Chemistry, Life and Civilisation. By H. T. S. Britton, D.Sc. (Lond.), B.Sc. (Bristol), D.I.C., F.I.C. Pp. vii+248. London: Chapman and Hall. Price 10s. 6d.

Dr. Britton has produced, under this somewhat grandiloquent title, an extremely interesting book dealing with a great variety of commercial applications of modern chemical discoveries. This is not his only aim for he gives a useful introduction to the fundamental chemical processes. Here I have one small criticism to make, the "make-up" of page 14 does not lend itself to easy reading, it is not apparent at once to which names the chemical formulæ apply. Very little more space would have been needed to make this perfectly clear. This is, of course, a very small matter. Against this I will place the very plain and easily read type in which the book is set up.

The book itself has many merits. Not least among these are the very clear and plentiful illustrations, both sketches in the text and very good photographs of modern plant and processes.

Dr. Britton has provided many a science master with just that material which he needs to turn chemistry from a mere subject on the curriculum to a life study. From vitamins, their discovery and value, to the generation of power, from the chemical process of the human body to glass-making, from the making of cloth (mercerising, etc.), to the production of nitrogenous fertilisers from the air, Dr. Britton takes us through all these and many more processes in a manner both interesting and accurate.

The student who is beginning a more serious study of chemistry will find here described for him the use to which many laboratory experiments have been put in the service of man.

This book includes many of the latest results obtained in the multitude of laboratories including the recent discoveries with regard to vitamins and their isolation or rather their concentration. Here we see that we are only in the stage of describing what they do and not exactly what they are.

I can whole-heartedly recommend this book to the harassed teacher, to the young student, and to that very numerous body of ordinary well-read people who will find here the result of much modern chemical research set down for them in a very interesting way.

Forthcoming Events.

FRIDAY, JANUARY 22.

Royal Institution. 21, Albemarle St., at 5.15 p.m. "Expanding Universe," by Sir A. Eddington.

S.C.I., *South Wales Section.* Joint meeting with the South Wales Section of the Institute of Chemistry. Technical College, Cardiff, at 7.30 p.m. "Benzidine and Tolidine as Reagents in Analyses," by R. G. Harry and E. A. Rudge.

Institute of Chemistry. *South Wales Section.* Joint meeting with the South Wales Section of the Society of Chemical Industry. (See above.)

S.C.I. *Liverpool Section.* Joint meeting with the Manchester Section. University, Liberpool, at 6 p.m. Jubilee Memorial Lecture: "Liquid Fuels, To-day and To-morrow," by Dr. A. E. Dunstan. Visit to the Ocean Petroleum Installation of the British Petroleum Co., Ellesmere Port.

S.C.I. *Manchester Section.* Joint meeting with the Liverpool Section. (See above.)

Institute of Chemistry. *London and South Eastern Counties Section.* Annual Dinner and Dance. Maison Lyons, 362, Oxford Street, W.1., at 7 for 7.30 p.m. Tickets 7s. 6d. single, 15s. double.

Oil and Colour Chemists' Association. *Manchester Section.* College of Technology, Manchester, at 7 p.m. Members' Evening. "After-treatment of Painted Surfaces," by F. Fancutt. "Emulsions—the Practical Application of Colloidal Chemistry to Paints," by A. Stewart.

TUESDAY, JANUARY 26.

Manchester University Chemical Society. University, Manchester, at 5 p.m. "Recent Work on Synthetic Drugs, by Dr. F. L. Pyman, F.R.S.

FRIDAY, JANUARY 29.

S.C.I. *Edinburgh and East of Scotland Section.* Joint meeting with the Glasgow Section of the Society of Chemical Industry and the Edinburgh and East of Scotland

Section of the Institute of Chemistry, 36, York Place, Edinburgh, at 7.30 p.m. "Liquid Fuels, To-day and To-morrow," by Dr. A. E. Dunstan.

S.C.I. *Glasgow Section.* Joint meeting with the Edinburgh and East of Scotland Section. (See above.)

INSTITUTE OF CHEMISTRY. Joint meeting with the Edinburgh and East of Scotland Section. (See above.)

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by permission of the Controller of H.M. Stationery Office and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., price 1/- weekly (annual subscription, £2 10s.).

Specifications Published.

363,870.—Grison, J.—Manufacture of solidified carbon dioxide and the like.

363,909.—Chemische Werke Vorm. H. and E. Albert.—Production of alumina and alkali phosphates.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

Group Abridgments can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., either sheet by sheet as issued on payment of a subscription of 5s. per Group Volume or in bound volumes, price 2s. each.

359,292.—Hydrofluoric acid.— Mond, A. L., 19, Southampton Buildings, London. (I. G. Farbenindustrie Akt. - Ges., Frankfort - on - Main, Germany.)

Hydrofluoric acid of low silica content is obtained from fluorspar and sulphuric acid by gently heating the pulp with stirring to expel silica as silicon fluoride, prior to driving off hydrofluoric acid, the concentration of the sulphuric acid being so low as to prevent solidification of the pulp. The concentration varies for example between 70 and 90 per cent., according to the *quantity of silica and other impurities,* the silicon fluoride being expelled in several hours at a temperature of 70-120° C. At higher temperatures hydrofluoric acid is *also finally volatilised,* but *can be retained* by a reflux condenser. The pulp can then be completely decomposed at a raised temperature. *Insufficient sulphuric acid, for* example 50 per cent. of the theoretical amount, may be added at the first stage, the remainder being added, if desired even as fuming acid, during or after expulsion of the silicon fluoride.

The Latest Trade Marks

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of His Majesty's Stationery Office.

FLUEXE.

525,185.—Chemical substances used for *agricultural, horticultural,* veterinary and sanitary purposes.—The Firm trading as Myers and Walmsley, Dolphin Place, Ardwick, Manchester. January 6.

BACTICIDE.

527,726.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—The Strawson Chemical Company, Limited, 79, Queen Victoria Street, London, E.C.4. January 6.

ZOPAD.

527,791.—Chemical substances used for sanitary purposes.—Thornton and Ross, Ltd., The Chemical Works, Colne Vale Road, Milnsbridge, Huddersfield. January 6.

AETHALIN.

527,879.—*Chemical substances included in* Class 1, for use in the treatment of textile fabrics and leather, in the course of their manufacture.—H. Th. Bohme Aktingesellschaft, 29, Moritzstrasse, Chemnitz, Germany. January 6.

THE CHEMICAL NEWS

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The Chemistry of the Conversion of Algæ into Bitumen and Petroleum and of the Fucosite-Petroleum Cycle

By J. E. HACKFORD, B.Sc., F.I.C.
Member of The Institution of Petroleum Technologists.

(*Continued from page* 59.)

SECTION II.

THE PRESENCE OF THE INTERMEDIATE PRODUCTS OF THE DECOMPOSITION OF ALGÆ IN NATURALLY OCCURRING OILS AND SEEPAGES.

The author recently had occasion to make a chemical examination of certain seepages of oils and bitumens and the oils from certain wells situate in an arid region of California. The rainfall was given as being less than 2in. per annum, whilst the day temperature reaches 110°F.—120°F. As in the case of the nitre beds of Chile, where the nitre persists because of the lack of water to wash it away, this particular region of California was peculiar, inasmuch as the sands contained appreciable quantities of water soluble substances related to, and co-existent with the oil and bituminous seepages found there.

There is a large dyke of solid bitumen running up the side of a cliff for more than a thousand feet. Upon analysis, the whole of the organic part (90 per cent.) of this seep was soluble in 1 per cent. solution of soda. Upon hydrolysis, this solution yields sugars, of which the pentose arabinose predominates. Tertiary amines and ammonium salts are also formed and, upon subsequent acid hydrolysis, oil results which can be isolated from the decomposition products.

In another seepage, oil, gas, and bitumen exist side by side in a sand which contained relatively large quantities of free sulphuric acid. Upon extraction with water, this sand gave a brown acid solution, which contained both free sulphuric acid and the sodium and calcium salts of the ethereal sulphonic esters. Upon hydrolysis, l-arabinose, tertiary amines, ammonium salts and oil were formed. When the aqueous solution was exposed to the atmosphere a mould (*cladothrix dichotoma*) readily formed upon the surface, and after a few days a heavy precipitate of calcium sulphate was deposited in the form of anhydrite.

All the seepages found contained an insoluble material, which swelled up in water like glue, and which could be hydrolysed yielding sugars, etc., as above. Traces of this substance were also found in the basic sediment of the crude oils found in the deep wells of the district, whilst the water accompanying the oil contained comparatively large amounts of sugars and traces of the salts of the naphthenic acids.

The fuel oil residue of the deep well oil yielded a similar material upon oxidation.

On extracting these residues with water at a steam pressure of 25lb./sq. in., a water soluble fraction was obtained, which upon acid hydrolysis yielded sugars, etc., as above.

SECTION III.

THE CONVERSION OF OIL INTO BODIES RESEMBLING THE FUCOSE-PENTOSANS.

It has already been recorded by the author[26] that asphaltenes change into kerols and keroles when subjected to gentle heating for a prolonged period of time. It has since been discovered that oils undergo a similar change and that oxidation plays the dominant rôle in this conversion. This conversion is the reverse of that which obtains in nature, whereby algæ, by a process of acid hydrolysis, undergo a form of degradation or reduction which results in the loss of oxygen. The kerols and keroles so formed resemble some naturally occurring seepages, and that upon acid hydrolysis they yield sugars, furfurol, tertiary amines, ammonium salts, etc., besides possessing other points of similarity. These artificial kerotenes (the class name, including kerols and keroles) also occur in nature. Twenty years ago oil gushers flooded the sands in various parts of the Elk Hills, California, and this pseudo-fucosite now abounds in the sands of the district. I have named this type of bitumen "Elkerite," as it is a naturally occurring product. As a class name the term "pseudo-fucosan" is suggested, as it yields pentose sugars upon hydrolysis, while the general term "pseudo-fucosite" is used to designate this naturally occurring type of product. Elkerite is therefore a pseudo-fucosite, produced by the oxidation of oil.

Experimental.

Section I.

The Formation of Oil by the Natural Decomposition of Algæ.

Three samples of algæ have been examined in order to show that they contain a similar range of elements to the oils and seepages examined in Section II.

The Mineral Constituents of Algæ.—The mineral constituents were qualitatively examined in the ash of the material by means of the arc spectrum, employing an E.8 Hilger Quartz Spectrograph, which enables exploration to be made of both the visible and ultra-violet regions.

The method has been to obtain a spectrogram of the spectroscopically standardised copper electrodes employed in juxtaposition with a *composite spectrogram of the sample* under investigation and of the electrodes, so that the extra lines appearing in the second spectrogram reveal the composition of the sample of material. It then remains to identify all these extra lines, or to search for those indicative of specified elements. The latter course has been followed to the extent of searching for the thirty-four elements which were most likely to be present.

Copper is not included in the list in consequence of the equipment being furnished with copper electrodes; nor mercury, because it is not detectable by ordinary routine analysis; nor the non-metals, except silicon, boron, and arsenic.

The *quantitative indications* are expressed in the following terms, and deduced from the relative intensities of the spectrum lines :—

(1) Minute trace; barely definite; only just observable spectroscopically.
(2) Very slight trace; first definite indication.
(3) Slight trace, but well defined indication, probably 0.008 per cent. of the ash.
(4) Trace; well marked, though small quantity; probably 0.01 per cent. of the ash.
(5) Heavy trace; say 3 times 4; probably 0.05 to 0.15 per cent. of the ash.
(6) Very heavy trace; probably 0.2 to 0.4 per cent. of the ash.

Although these approximations are a very fair indication of the quantities present *in the portion* of the material *utilised* in the *spectrographic experiment, they must* be considered in two aspects when the results are applied to the original material : (*a*) the quantity of ash available is sometimes very small and sometimes abundant; (*b*) the proportion of ash obtained from the original material varied from a minimal proportion from an oil to the maximum in a mineral substance.

In the few cases marked "(?)" the indication is probably correct, but not sufficiently definite to leave it unqualified.

The qualification "probably" in the case of potassium, molybdenum, *etc., is* due to the lines of these elements, when present in only very small proportions, being confused by closely neighbouring lines. The experimental results are detailed in the following tables :—

Elements	1 Coorongite	2 Macrocystis pyrifera	3 Sargassum
Aluminium ...	much	+	4+
Antimony	prob. absent	0	0(prob.)
Arsenic	2+	+	0
Barium	4+	3+	5+
Beryllium	0	0	0
Bismuth	0	0	0
Boron	5+	5+	+
Cadmium	0	0	0
Caesium	0	0	0
Calcium	much	much	much
Chromium	2+	+	0
Cobalt	0	0	0
Germanium... ...	0	0	0
Indium	0	0	0
Iron	much	5+	6+
Lanthanum... ...	0	0	0

Lead	2+	+	3+
Lithium	5+	5+	3+
Magnesium	much	much	much
Molybdenum	prob. absent	0	0
Nickel	2+	0	+(?)
Niebium	0	0	0
Potassium	prob. absent	much	0
Rubidium	0(?)	0	0
Silicon	5+	+	+
Silver	0	+	0
Sodium	a little	much	much
Strontium	5+	much	much
Thallium	0	0	0
Tin	+	0	0
Titanium	4+	0	0
Vanadium	3+	0	0
Zinc	4+	0	6+

1. Coorongite from Australia. Dyer, *Journal of Botany*, 1872, p. 103.
2. Macrocystis pyrifera. Sample from California. Obtained from Natural History Museum, S.K.
3. Sargassum. Sample from Lake Titicaca, Peru.

Preparation of the aqueous extract of Aglæ. The sample of sea-weed was collected at Brighton and the *laminaria digitata* separated and identified. After washing in fresh water to remove sand, dirt, etc., the material was spread out to dry in the air for one day. One kilo. was then placed in a linen bag and put on the perforated shelf of the autoclave in which was 1 litre of distilled water. The autoclave was then placed over a burner and heated until a pressure of 25lb./sq. in. was registered, and then maintained at that pressure. It was observed that the liquors were alkaline to litmus after heating for two hours. The water was then changed and collected and another litre of water added to take its place in the autoclave. After 24 hours heating at the same pressure, the liquors were neutral in reaction. The two liquors so obtained were added together, and third litre of water added. This was heated for a further 24 hours, after which the liquors were acid to litmus. The autoclave was then heated for another 24 hours, after which the liquors showed a strongly acid reaction.

Solutions made by digesting the weed for two hours only were also used in the experiments described below.

Some Properties of a Two Hour Alkaline Aqueous Extract. The Development of Acidity.

(1) *On standing.*—A solution containing 1.2817 gms. of solid matter per 100 ml. was used in the following experiments :—

(*a*) No evolution of ammonia was observed on heating the solution with strong caustic soda, from which it is inferred that ammonium salts as such were absent.

(*b*) The carbylamine reaction gave a negative result from which it is inferred that primary amines were absent.

(*c*) Tungstic acid[27] in hydrochloric acid solution gave no precipitate, from which it is inferred that tertiary amines were absent.

(*d*) After standing for one week, the solution threw down a brown precipitate consisting of an organic body similar to that thrown down during acid hydrolysis, or upon the addition of sulphuric acid. Some calcium sulphate was also precipitated.

(*e*) After standing for one week, the solution gave a precipitate with barium chloride, having developed acidity during that period.

(*f*) Sulphuric and hydrochloric acids both threw down the same brown precipitate as in (*d*).

---

[27] The tungstic acid used in these experiments is a colloidal solution in hydrochloric acid. It has the property of giving a bulky flocculent precipitate with tertiary amines. The reverse reaction is used in the separation of tungsten from other metals in its ore; in this case the tungsten is precipitated by the addition of quinoline.

2. *On oxidation by blowing aid through the aqueous solution.*

(*g*) After blowing air through the solution on the water bath for four hours the reaction became acid to litmus. After blowing for three days a precipitate was thrown down similar to (*d*).

(*h*) Free sulphuric acid developed as in (*e*).

3. *By bacterial action.*

(*i*) Upon exposure to the air in an open dish, a mould formed on the surface (*cladothrix dichotoma*). After one week the solution became acid as in (*e*), and after one month there was a copious precipitate as in (*d*).

The Acid Hydrolysis of Algæ.—Because of the tendency of aqueous extracts of algæ to change their character from the alkaline to the acid condition as described, it was considered that alkaline hydrolysis in nature must of necessity be of short duration. The available time for subsequent acid hydrolysis in nature must of necessity be of short duration. The available time for subsequent acid hydrolysis is unlimited. Because of the formation of free sulphuric acid it was considered that this acid was the actual hydrolysing agent which brought about the changes in the chemical constitution of the algæ in nature.

The Acid Hydrolysis of the two-hour Alkaline Aqueous Extract of Seaweed.—The addition of 5 per cent. by weight of sulphuric acid to one litre of the alkaline extract caused the precipitation of 0.396 gms. of a brown precipitate of algarite. (See definition and p 53, this Vol.). Hydrochloric acid precipitated the same material in approximately the same quantity (0.389 gms.). This precipitate was filtered off. The filtrate was treated with various reagents, whose reactions are given below, and also one litre was hydrolysed for two days, and another litre for seven days by gentle boiling under a reflux condenser. A skin formation was noted on the sides of the flask as observed by Haas and Wells.[16]

At the end of these periods of time the freshly formed algarite was filtered off and the filtrates were treated with reagents, and the following table shows the difference in their behaviour as hydrolysis proceeds. The oil formed during hydrolysis appears in the table as "Chloroform Extract," and for convenience, all results are calculated on the litre basis.

THE ACID HYDROLYSIS OF THE 2-HOUR ALKALINE AQUEOUS EXTRACT (12.31 GMS. SOLIDS/LITRE) OF SEAWEED.

Reagent used.	Before acid hydrolysis			After 2 days' hydrolysis			After 7 days' hydrolysis		
	Weight in gms. of precipitates, organic matter and ash, calculated per litre of solution.								
	Precipitate	Organic matter	Ash	Precipitate	Organic matter	Ash	Precipitate	Organic matter	Ash
Sulphuric Acid. Yielding algarite ...	0.396	0.369	0.027	0.934	0.819	0.115	5.354	5.297	0.057
Ethyl Alcohol. Yielding the calcium salts of the sulphonic esters	3.518	2.530	0.988	2.740	0.909	1.831	1.628	0.074	1.554
Tungstic Acid. Yielding tertiary amines	nil	nil	nil	2.722	1.488	1.234	2.294	1.098	1.196
Ammonia. Yielding ammonium salts (?)	nil	nil	nil	0.242	0.208	0.039	nil	nil	nil
Chloroform. Extracting oil and fatty acids	nil	nil	nil	0.626	0.626	0.000	1.274	1.274	0.000

A HYDROGEN ISOTOPE!

By F. H. Loring.

News from United States of America that a hydrogen isotope has been discovered comes as a surprise to many investigators of atomic phenomena, but until this is confirmed it would be wise to treat the report as uncertain.

Nevertheless it is of interest to examine the problem from the point of view of regularity by the method of the present writer in the *Chemical News*, Dec. 25, 1931, vol. 143, particular page 409.

At first sight an isotope of hydrogen does not seem to fit in, but as its mass has not been announced as determined by the positive-ray method, it may be 2, as suggested in the report, in which case the scheme previously shown (p. 409) can be drawn up thus :—

At. No.
$2 \times 3 + 0 = 6 = Li^{6}$
$1 \longrightarrow$
$2 \times 1 - 1 = 1 = H^{1}$
$1 \longrightarrow$
$2 \times 1 - 0 = 2 = H^{2}$

At. No.
$3 \times 37 - 26 = 85 = Rb^{85}$
$6 \longrightarrow$
$3 \times 55 - 32 = 133 = Cs^{133}$
$6 \longrightarrow$
$3 \times 87 - 38 = 223 = \text{Eka-}Cs^{223}$

$2 \times 55 + 23 = 133 = Cs^{133}$
$10 \longrightarrow$
$2 \times 37 + 13 = 87 = Rb^{87}$
$10 \longrightarrow$
$2 \times 19 + 3 = 41 = K^{41}$

$2 \times 3 + 1 = 7 = Li^{7}$
$0 \longrightarrow$
$2 \times 11 + 1 = 23 = Na^{23}$
$0 \longrightarrow$
$2 \times 19 + 1 = 39 = K^{39}$

$3 \times 119 + 28 = 385 =$ ——
$10 \longrightarrow$
$3 \times 137 + 18 = 429 =$ ——
$10 \longrightarrow$
$3 \times 155 + 8 = 473 =$ ——

See page 409 for leading up particulars, etc. (see also page 360 of same vol.).

At. No.
$2 \times 21 + 3 = 45 = Sc^{45}$
$2 \longrightarrow$
$2 \times 13 + 1 = 27 = Al^{27}$
$1 \longrightarrow$
$2 \times 5 - 0 = 10 = B^{10}$

At. No.
$3 \times 39 - 28 = 89 = Yt^{89}$
$4 \longrightarrow$
$3 \times 57 - 32 = 139 = La139$
$8 \longrightarrow$
$3 \times 89 - 40 = 227 = Ac^{227}$

$2 \times 5 + 1 = 11 = B^{11}$
$0 \longrightarrow$
$2 \times 13 + 1 = 27 = Al^{27}$
$2 \longrightarrow$
$2 \times 21 + 3 = 45 = Sc^{45}$

In order to test the regularities further, Groups V and VII are worked out as follows :—

At. No.
$2 \times 23 + 4 = 50 = V^{50}$?
$3 \longrightarrow$
$2 \times 15 + 1 = 31 = P^{31}$
$1 \longrightarrow$
$2 \times 7 - 0 = 14 = N^{14}$

At. No.
$3 \times 41 - 30 = 93 = Nb^{93}$?
$6 \longrightarrow$
$3 \times 59 - 36 = 141 = Pr^{141}$
$6 \longrightarrow$
$3 \times 91 - 42 = 231 = Pa^{231}$?

$2 \times 7 + 1 = 15 = N^{15}$
$0 \longrightarrow$
$2 \times 15 + 1 = 31 = P^{31}$
$4 \longrightarrow$
[illegible] $= V^{51}$

At. No.

$2 \times 25 + 5 = 55 = Mn^{55}$

2 ⟶

$2 \times 17 + 3 = 37 = Cl^{37}$

3 ⟶

$2 \times 9 - 0 = 18 = F^{18}$?

At. No.

$3 \times 43 - 30 = 99 = Ma^{99}$?

6 ⟶

$3 \times 61 - 36 = 147 = Il^{147}$?

6 ⟶

$3 \times 93 - 42 = 237 =$ ——

$2 \times 9 + 1 = 19 = F^{19}$

0 ⟶

$2 \times 17 + 1 = 35 = Cl^{35}$

6 ⟶

$2 \times 25 + 7 = 57 = Mn^{57}$?

I	III	V	VII
1	2	3	2
1	1	1	3
2	3	4	5

I	III	V	VII
0	0	0	0
0	2	4	6
0	2	4	6

I	III	V	VII
6	4	6	6
6	8	6	6
12	12	12	12

Including praseodymium (Pr) and illinium (Il) simply means that the groups are Mendeléeffian rather than those in which the rare-earth elements are taken out of the main scheme. In other words they are groups of the simplest order by taking the natural sequence of the elements by atomic number, as shown in the present writer's Wedge Periodic Classification (see THE CHEMICAL ELEMENTS, 1923, p. 34) which is reproduced below.

The atomic-weight values for Ma and Il are those worked out by the present writer (*Chemical News*, 1926, *132*, 410), as is the one for actinium (*Chemical News*, 1911, *104*, 59), the early value being estimated at 226.5, which is practically 227. In this connection the present writer (*Chemical News*, 1909, *100*, 283) showed a gap in a periodic-table series, comprising the rare-earth elements, for a then undiscovered element between Nd and Sa. Illinium now fills this gap.

Returning to the main issue of this paper, it would appear that the above development supports the report from America, mentioned above; but, no doubt, schemes of this kind will require many changes as time goes on.

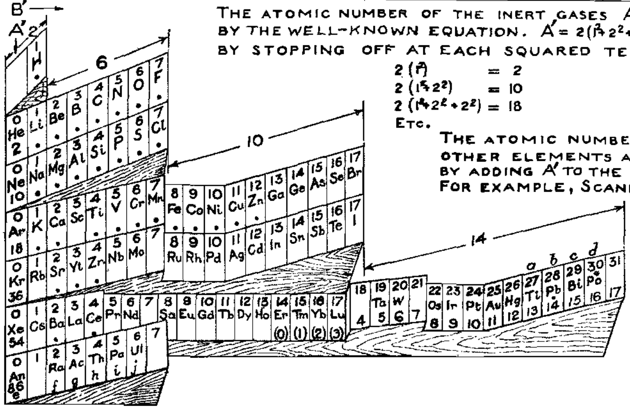
It will be seen that by slipping along the very long "wedge," so as to bring the elements of Group VIII together, Hf falls under Zr, yet in the present position Ce falls under Zr. These two elements are not, of course, isotopic and their masses differ greatly. Similarly, in the case of H=1 and H=2, there is an even bigger relative difference in their masses, assuming this duality, so that here too these hydrogens may not be isotopic in the fullest meaning of the term. Counting them as two elements and allowing one each for the gaps represented by atomic numbers 87 and 93 makes exactly 45 for the main section bordered by H, Li, Na, K, Rb, Cs, Eka-Cs. The grouping headed by Cu, Ag, Au makes 21 elements when including eka-iodine. The "neutron" makes up the inert gases to 7. The rare-earth elements Pr to Lu inclusive=13. The proton and electron might represent members of an initial group of 3. Thus the probability numbers 3, 7, 9, 13, 21, 45, map out the periodic table in a systematic manner. The best way to show this is to colour the sections of the above table just as one would a map. Hydrogen being on a steep or high wedge becomes thereby represented as eligible with fluorine, but otherwise linked up to the alkali metals as it has only one so-called orbital electron. If H=2 exists also, then the wedge might be made deeper and divided in two parts simulating the double wedges below it. It will be seen that each wedge-pair drops less in going down the table, the last wedge should therefore be drawn a little lower to show this uniformity. That is to say, the angle to be slightly less than shown. The illustration on page 72 indicates this more clearly.

THE WEDGE PERIODIC TABLE OF THE ELEMENTS
(BASED ON ATOMIC NUMBERS AND ATOMIC LEVELS)

THE ATOMIC NUMBER OF THE INERT GASES A' IS GIVEN BY THE WELL-KNOWN EQUATION. $A' = 2(1^2+2^2+2^2+3^2+3^2+4^2 \ldots)$, BY STOPPING OFF AT EACH SQUARED TERM THUS —

$2(1^2) = 2$
$2(1^2+2^2) = 10$
$2(1^2+2^2+2^2) = 18$
ETC.

THE ATOMIC NUMBERS OF ALL THE OTHER ELEMENTS ARE OBTAINED BY ADDING A' TO THE B' NUMBERS. FOR EXAMPLE, SCANDIUM IS $3+18=21$.



THOSE ELEMENTS OCCURRING IN GREATER ABUNDANCE ON THE EARTH ARE INDICATED BY A BLACK SPOT.

THE RADIO-ELEMENTS FIT INTO PLACES a, b, c, ETC., AS ISOTOPES OF THOSE INSERTED TO CHARACTERISE THE PLACES.
ATOMIC NUMBER OF H = 1.
THERE ARE ONLY TWO RADIO-ELEMENTS IN THE PLACE CHARACTERISED BY Pa, VIZ: Pa AND UX_2.

* OR RADIUM F (RaF)

2 : 4 : 6-TRINITRO 1 : 3 : 5-TRIAZIDO-BENZENE.

By Dr. O. Turek.*

There has been a tendency in recent years to find substitutes for mercury fulminate as a priming substance and as a detonator.

The new explosive, 2 : 4 : 6 :-trinitro-1 : 3. 5-triazido-benzene, is one which it is suggested is among the best organic compounds fulfilling the qualities to be desired in such a substance. The author first prepared this compound in 1924 when working with Professor Cyril Krauz. The starting product was aniline which was chlorinated to give symmetrical trichloro-aniline which on diazotising and warming gave trichlorobenzene. This compound on nitration with nitric acid and fuming sulphuric acid yielded, trinitrotrichlorobenzene which was finally converted into trinitro-triazido-benzene $C_6(NO_2)_3(N_3)_3$ by means of sodium azoimide. The author has patented this last stage of the conversion which is best carried out in alkaline solution.

The new explosive is a greenish yellow solid, easily soluble in acetone and chloroform but only slightly so in alcohol and is quite insoluble in water. It melts at 131° C. evolving nitrogen and leaving hexanitrosobenzene. It is neutral, non-hygroscopic and is unaffected by moisture. When kept in the dark it showed no change after three years nor did it act upon metals. Light acted upon it, gradually darkening it on the surface. The compound burned easily in air with a blue flame. Under even slight compression in a metal tube it detonates with violence but it is relatively stable and responds but feebly to friction.

On analysis .1667 gr. gave .1300 CO_2 and .06177 N_2. Found : C, 21.28 and N, 49.82; Calculated for $C_6O_6\ N_{12}$, C, 21.42 and N, 50.01 per cent. Molecular weight, found 334.6 and 336.7; calculated 336.09.

From a careful technical study of quantities of the substance and observations upon its temperature of decomposition, the author concludes that it is eminently suitable as a detonator for explosives.

* We have received from Dr. O. Turek, a reprint of his paper which appeared in *Chimie et Industrie*, October, 1931, and the outstanding points thereof are discussed herein.

CHINA-CLAY (KAOLIN).*

It is perhaps not generally realised that kaolin, the white powdery disintegration product of felspar, is no longer mainly used in the manufacture of porcelain. The pottery industries still absorb some 30 per cent. of the output, but the bulk of the kaolin produced to-day is used in the manufacture of various classes of paper ranging from wallpaper to the finer grades of "art paper." Not a little also finds application in pharmacy and even in medicine for internal application. Some is used for admixture with pigments, with size, linoleum, rubber, etc. On the continent and in the U.S.A. kaolin and kaolin residues are extensively used in the manufacture of certain glasses. Finally, considerable quantities of china-clay are converted into aluminium sulphate and alums, for it must be remembered that kaolin is more or less pure hydrated aluminium silicate, Al_2O_3 $2SiO_2$ $2H_2O$. If some simple method could be found for removing the silica, kaolin would become a cheap and convenient source of metallic aluminium.

Even the whitest samples may contain impurities such as traces of free silica, alkalies and the oxides of iron, calcium, magnesium and titanium. Although china-clay is widely distributed, commercially valuable deposits of good quality are relatively few, the most important being our deposits in Cornwall and Devon, and those in Czechoslovakia, Germany, U.S.A. and China.

In Cornwall the clay is obtained by open working and is washed out with a stream of water. The sand and coarse material is allowed to settle and the clay wash is successively thickened to the consistency of cream and can be dehydrated to contain about 50 per cent. water. In Czechoslovakia an electro-osmose method is frequently adopted, *e.g.*, in the Karlovy Vary (Carlsbad) district, whilst near Plzen (Pilsen) sedimentation and filterpress methods are followed. In parts of the U.S. a bowl classifier method is adopted and

* *The Mineral Industry of the British Empire and Foreign Countries. China-Clay (Kaolin).* Imperial Institute. Pp. 100. London : H.M. Stationery Office. 1931. Price 1s. 6d.

various chemical processes have been patented for the purification of clays.

At present there is no recognised standard of comparison of china-clays of varying qualities. For the ceramic industries it was customary to judge by the colour after firing. "Best," "good medium," medium," and the other classifying terms are quite arbitrary and are of little value in regard to other uses to which kaolin is now so extensively put. Producers and users could profitably co-operate in studying the most suitable products for each particular use. As it is at present no less than 40 different clays are marketed as " the best clay for paper purposes."

Search could also be profitably made into remunerative outlets for the utilisation of the waste products which accumulate in refining china - clay. The most important waste material in Cornwall is the quartz sand of which some million tons accumulate in a full working year. At present limited use is found for a fraction of this in making fire-bricks and road-making materials. Possibly it could be used more extensively for incorporation in artificial building stones. In some Czechoslovak districts the finer sand is disposed of to the glass works and the coarser quartz being used for making concrete.

The finest continental china-clay comes from Sedlice (Zettlitz) near Carlsbad (Czechoslovakia), which is extraordinarily plastic in spite of being almost pure kaolinite. It is used for the manufacture of the finest porcelain. The china-clay from the Plzen district is consumed chiefly by paper works and chemical factories. Some, however, is used for making stoneware and white tiles. About half the Czechoslovak output is exported.

So far as the output for 1930 of kaolin is concerned the United Kingdom produced 716,000 tons, Czechoslovakia 400,000, Germany 879,000, U.S.A. 455,000, and China 800,000 tons. The lowest 1930 price was 28s., and the highest English 67s. 9d. per long ton.

INNOVATION IN EMPIRE MEETINGS.

On 14 January a joint meeting was held at the Board of Trade, Gt. George Street, London, S.W.1., and Science House, Sydney, N.S.W., between the British Standards Institution and the Standards Association of Australia. The meeting was held by wireless and the step taken undoubtedly marks another advance in tranoceanic telephone communication.

The transmission during this whole meeting was excellent. The meeting was included in the broadcast programme in Australia.

The following were present :—

LONDON.

Col. Sir Thomas Purves (Chief Engineer, General Post Office) (Chairman); The Rt. Hon. Watler Runciman, M.P. (President of the Board of Trade); Mr. Maurice F. G. Wilson (Chairman, British Standards Institution); Sir William Larke, K.B.E. [Member of Council (Chairman of Iron and Steel Industry Committee)]; Mr. Ll. B. Atkinson [Member of Council (Chairman of Finance Committee)]; Mr. P. W. L. Ashley, C.B. [Board of Trade (Member of Council)]; Mr. H. J. Hutchinson (Board of Trade); Dr. E. Franklin Armstrong, F.R.S. [Member of Council (Chairman of Chemical Divisional Council)]; Mr. W. Reavell [Member of Council (Chairman of Mechanical Industry Committee)]; Mr. Percy Good (Deputy Director, British Standards Institution).

AUSTRALIA.

Sir George Julius (Chairman of the Standards Association of Australia); Sir Henry Barraclough (Dean of Faculty of Engineering, University of Sydney); Mr. V. J. F. Brain (Public Works Department, N.S.W.); Mr. E. P. Fiske (General Manager of Amalgamated Wireless of Australia); Mr. A. Gibson (Consulting Engineer); Mr. W. R. Hebblewhite (Secretary of Standards Association of Australia); Mr. C. Hoskins (General Manager of Australian Iron and Steel Co.); Mr. R. B. Hungerford (Manager and Director Standard Telephones of Australia, Ltd); Mr. F. Kneeshaw (Chief Engineer and General Manager of Kandos Cement Co.); Mr. R. Lawson (Superintendent Engineer, Postmaster General's Department); Mr. W. H. Myers (Chief Electrical Engineer of the N.S.W. Government Railways); Mr. C. le Maistre, C.B.E. (Director of British Standards Institution).

Col. Sir Thomas Purves opened the meeting for Great Britain and later introduced the Rt. Hon. Walter Runciman, President of the Board of Trade, who remarked upon inter-Imperial co-operation in the use of industrial standards.

Sir George Julius, replying from Australia, spoke of the necessity for the stimulation of inter-Empire trade, which a standardisation of measure and design greatly assisted. He commented in warm terms on the visit to Australia of Mr. le Maistre, the Director of the British Standards Institution and he further regarded Mr. le Maistre's presence in Australia at this time as potent to the success of reciprocity in Dominion trade.

Mr. le Maistre then spoke to the meeting from the Australian side and pointed out that understanding of the markets of Empire was necessary before trade in large quantities could ensue. His suggestion was "Come and see for yourselves."

Sir Thomas Purves then declared the meeting closed.

THE AMERICAN INSECTICIDE INDUSTRY IN 1931.

In England we do not pay sufficient attention to the organising of our insecticide products and manufacturers are reluctant to pass over to each other facts relating to their trade and systems. With our friends on the other side of the Atlantic however, a different attitude is adopted with the result that the Insecticide industry is well organised and periodical conferences throw much light on improvements in manufacture, trading methods and policies.

The household insecticide industry did approximately a $10,000,000 volume of business in the manufacture of chemical sprays to destroy insect pests in the United States in the year just closed.

This monetary volume was, of course, lower than would have been the case had the year been an economically normal one. An increasing public demand for products of reputable companies aided the leaders in the industry materially, however, and all the leading manufacturers are ending the year in a much stronger financial condition than are many leaders in other fields.

The prediction of many authorities that the depression will pass in 1932, and that normalcy will be well on its way after midsummer, appears to be sound. The insecticide industry can undoubtedly look forward to an increase of at least 25 per cent. in its business in the coming year.

The warm summer and later winter this year will accelerate next year's business. The balmy weather allowed insects to hibernate in greater numbers, according to entomologists, who look for an increased number of household pests, flies, mosquitoes, roaches, moths, fleas, bedbugs and ants, in the spring.

Public education and advertising did much to carry the industry through the year. It will do more in 1932. The public is growing more and more conscious of the need of hygiene and sanitation from the standpoint of health and comfort and of the menace of germ-carrying insects. This consciousness is exemplified in the discovery of scientists that a single fly can carry more than 6,000,000 germs, including those of thirty human ailments.

Both the industry and the public continued to suffer harm in the past year from the effects of irresponsible and untested, sometimes dangerous, insecticide formulas made up and sold by small "wildcat companies" in 1931.

This is reflected in the fact that there were about 6,000 different household insecticides on the market in various part of the country. Laboratory tests established the fact that only seven or eight of the many thousands offered the public are efficient.

Many were found to be inflammable. Others were harmful to fabrics. Some were little more than smelly liquids. These inefficient products are seldom advertised, and the public can avoid the dangers attending their use by insisting on buying well-known and well-advertised insecticides which, through extensive scientific research, have been made highly destructive to insects and entirely harmless to humans and home furnishings.

SYNTHETIC RUBBER OPENS NEW ORGANIC CHEMISTRY FIELD.

Recent discoveries regarding the synthesis of rubber open up "a new field in organic chemistry," according to Professor Marston T. Bogart of Columbia University, one of the speakers before the American Chemical Society, meeting at Yale. His statement was made in commenting on the research of Dr. Wallace H. Carothers, chemist, of the du Pont de Nemours Co., who described two compounds which react with themselves to form products strongly resembling rubber. The compounds are chloroprene and bromoprene.

FRANCO-GERMAN NITRATE PACT.

France made a desperate attempt last year to impose a tax on imported nitrate, but without avail. Now she has announced the details of the agreement between herself and Germany under which France is to purchase at least 200,000 tons of synthetic nitrate from German producers and "to buy nitrate in sufficient tonnage to satisfy the needs of French agriculture and industry."

This action on the part of the French Government bears out the report printed in "Chemicals" (New York) of December 28, 1931.

The situation is a peculiarly involved one and follows closely upon the statement following the collapse of the recent nitrogen conference at Paris and the action of the French Government in endeavouring to collect a duty of $8,00 a ton on imported nitrates, $4.00 of which would go to French farmers and growers and $4.00 to the French nitrogen industry to reduce its excessive overhead costs.

There was an immediate protest from the importers of the Chilean, Scandinavian, British and American products, who refused to handle nitrates under the proposed taxation, and, it is stated, informal protests were made by the several Governments involved.

The French have now cut the knot by turning to their former opponent for nitrate supplies, although 150,000 to 200,000 tons of this material are always held as a war-time reserve by the French Government.

Recent French purchases from Chile totalled 209,000 tons: France consumes approximately 350,000 to 400,000 tons a year—and the German output is placed between 85,000 and 100,000 tons—hence, the uncertainty on the part of France, and the hope still expressed by other producers that they may yet get a part of this business.

The agreement just entered into was only semi-official in that it was signed by the French and German nitrogen offices, which are but semi-governmental. The supply will come through the German Chemical Trust, I. G. Farbenindustrie covering the "nitrate year" of 1932, which is about from January 20 to September 1.

The communique merely says the deal will permit the French agriculturist to get fertiliser at a price, 10 francs per 220 pounds lower than the current rate. The present price of 105 francs was set at the request of the French nitrogen industry last August, so the new price will be 95.

If a contract is concluded, it would run from January 20 to September 1, when the present German contract also will terminate. France will require 400,000 tons of nitrates during 1932, of which Chile already has furnished 200,000 tons.

THE INTERNATIONAL NITRATE SITUATION.

New Joint Offer from United States, Chile and Norway.

American, Chilean, and Norwegian nitrate companies having made a new joint offer to the French government to maintain stocks of 125,000 tons of nitrate in France at the disposal of the war department if the government would permit the nitrate to be sold to farmers, says a U. P. cable from Paris. Acceptance of the offer appeared likely in view of the government's depleted war stocks.

The Comptoir de l'Azote, which does the buying for the government, notified the Chileans, Americans, and Norwegians informally that it might buy additional nitrates at the rate paid the Germans, fr. 83 per 100 kilograms, but did not stipulate the amount that might be purchased. The price was considered low compared with previous deals.

NEW ZEALAND KAURI GUM EXPORTS.

Exports of gum from New Zealand dropped from 3,207 metric tons, having a value of £157,687 for the first nine months of 1930 to 2,816 tons, valued at £99,604 for the corresponding months of 1931. Of special significance in the trade is the replacement of the United States as the principal purchaser by the United Kingdom whose receipts are increasing to the extent that over 50 per cent. of the total exportation comes to this country. The opinion expressed by those in the trade is that the increase of gum imports by the United Kingdom is attributed partly to re-exports to Russia. Present demand is very largely for high grade gums, it being difficult to dispose of the poorer grades.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

January 21, 1932.

The following papers were read :—

Studies in the Nervous Control of Carbohydrate Metabolism, I, II, III. By C. Donhoffer and J. J. R. Macleod, F.R.S.

When decerebration is performed through the pons of rabbits under amytal anæsthesa the percentage of blood sugar rises very high *after* the effects of the anæsthetic have passed off. Decerebration at any other level of the brain stem does not usually affect the percentage of blood sugar. Evidence is presented which indicates that puncture of the floor of the fourth ventricle is followed by hyperglycæmia only provided the pons is involved and reasons are given for believing that stimulation, rather that destruction, of some diabetogenic centre or pathway is responsible for causing it.

After pontine decerebration the percentage of lactic acid increases in the blood and the percentage of glycogen decreases in the muscles but may either increase or decrease in the liver. These changes are, as a rule, insignificant after decerebration at other levels. No relationship exists between the degree of decerebration hyperglycæmia and the percentage of glycogen initially present in liver and muscles, and when previously fasted animals are used it is impossible to account for the hyperglycæmia by the sugar arising from the glycogen which disappears. It is concluded that a process of gluconogenesis is responsible for most of the extra sugar, but it has so far proved impossible to determine the extent to which protein and fat contribute towards its production.

In fasted animals, having small percentages of glycogen in the liver and muscles, pontine decerebration fails to induce hyperglycæmia under the following conditions : (1) Double adrenalectomy; (2) administration of atropine, ergotamine or amytal. When the decerebration is performed on animals recently fed with carbohydrates the conditions just mentioned fail to prevent the development of a certain degree of hyperglycæmia.

It is concluded that decerebration hyperglycæmia is in large part due to stimulation through the autonomic nerves of some process by which the liver discharges sugar in excess of that available from the glycogen initially present in it. Since amytal paralyses this pathway it prevents the rise in blood sugar percentage following pontine decerebration, piqûre and asphyxia but not that due to the injection of large doses of adrenaline.

X-Ray Analysis of the Structure of the Wall of Valonia ventricosa, I. By W. T. Astbury, T. C. Marwick and J. D. Bernal. Communicated by Sir William Bragg, F.R.S.

The alga, *Valonia ventricosa*, grows in form of a single-celled hollow sphere often as much as 2 cms. in diameter. The cell-wall is found by X-ray methods to be built *up of two main sets of cellulose chains* which form crystallites crossing at an angle which is maintained remarkably constant through the whole thickness and over considerable areas of the wall.

The orientations of the cellulose chains are found to be parallel to the directions of the fine crossed striations which may be detected on the surface of the wall when examined under the microscope.

The extinction directions shown by the wall in polarised light lie between the directions of the cellulose chains and vary in a manner determined by the inter-chain angle and the relative proportions of the chains associated with each orientation.

Refractive indices and optic axial angles have been measured for those areas of the wall which behave optically as single crystals.

The nature of the orientating forces which fix the directions of the cellulose chains in the cell-wall is discussed in the light of the above observations.

Crystalline Vitamin D. By F. A. Askew, R. B. Bourdillon, H. M. Bruce, R. K. Callow, J. St. L. Philpot and T. A. Webster. Communicated by Sir H. H. Dale, Sec. R.S.

Further purification of the antirachitic principle has been achieved by esterification of the crystalline distillation products formerly described as calciferol. The purified calciferol now obtained has an antirachitic activity twice as great as any previously recorded, and appears to be identical with theh vitamen D_2 of Linsert and Windaus.

The purified product still produces toxic effects when given in excessive doses.

A simplified process is described for preparing the pure product from the irradiation products of ergosterol without distillation.

An account is given of two inactive compounds termed pyrocalciferol and sterol X.

Evidence is given of the relations between the crystalline antirachitic products hitherto described, showing that the activity of each of them is due to one common constituent. Thus the vitamin D_1 of Windaus is a compound of calciferol (=vitamin D_2) and sterol X, and the crystalline distillation products first described contained pyrocalciferol and sterol X, as well as calciferol.

It is shown that the separation of a series of crystalline products, showing equal antirachitic activity, but widely different optical rotations, may be accounted for by the existence of solid solutions of the two molecular compounds, calciferol-pyrocalciferol and calciferol-sterol X. Melting-point data are given showing that this system affords an interesting study in the application of the phase rule.

The probability is discussed that calciferol (and vitamin D_2) represent " vitamin D " in a state of approximate purity.

Notices of Books.

The British Journal Photographic Almanac, 1932. Edited by George E. Brown, F.I.C.. 684 pages and 64 pages of photogravure supplements. London: Henry Greenwood and Company, Ltd., 24, Wellington Street. 2s. net (paper covers); 3s. net (cloth bound).

Every camera user will welcome the 1932 volume of the " British Journal Photographic Almanac," the big book of photography which costs only 2s. First there are the delightful pictorial pages in photogravure. These sixty-four reproductions make a magnificent collection of camera pictures. In the text, an editorial article describes recent developments in photography : J. E. Saunders, F.Z.S., the well-known Zoo specialist, tells—and shows—how animal photography should, and should not, be done : and other articles deal with the new roll films, giving better snapshot pictures than ever before, and with the latest practice in development, including a new method which gives greatly improved snapshots. Then there are editorial reviews of the latest new cameras and other apparatus; and numerous hints, expedients and formulæ for almost every branch of photography.

Test Papers in Arithmetic. By W. Smith, B.Sc., A.I.C. Part I, Pp. 48+viii. Part II, 48+vii. London : John Murray, Albemarle Street, W. 1932. Price 9d. each part.

Busy science masters will welcome these graduated test papers in arithmetic which Mr. Smith has evidently arranged with considerable care and forethought.

The scope of the papers may be illustrated by a few typical questions. Thus, in Part I, we find on page 18 :—

" 3. The cage at a colliery is raised by a steel cable which is wound 78 times round a drum 38ft. 3in. in circumference. Find, to the nearest yard, the depth of the shaft.

" 4. An ingot of copper of volume $4\frac{1}{2}$ cu.ft. weight 1 ton 235 lb. Find the weight of a cubic foot of copper.

" 6. It appears from figures published in *The Times* in February, 1931, that, on an average $157\frac{1}{2}$ million gallons *per hour* more water flow over Victoria Falls than over Niagara. If 81 million gallons *per minute* pass Victoria Falls, how many pass Niagara in the same time?"

Those in Part II are for more advanced pupils; like the earlier ones they are drawn from everyday experiences and thus indicate the practical utility of the various rules and methods. Following are instances from the second part.—

" A sulphuric acid works has a chamber capacity of 140,000 cu.ft. One lb. of sulphur is burned per 24 hours per 20 cu.ft of chamber space. Find to the nearest ton the weight of acid made per week of 7 days." (p. 35.)

" A motorist finds that 1 lb. of petrol will take his car as far as 1 lb. of benzole. If 1 gal. of petrol takes him 19 miles and weighs 7.8 lb. and 1 gal. benzole weighs 8.8 lb., find to the nearest mile how much farther his tank (holding 12 gals.) full of a mixture half petrol and half benzole will carry him than if filled with pure petrol." (p. 40.)

Mr. Smith has included a number of miscellaneous " puzzles " that are intriguing and his whole collection should appeal to young pupils who will be stimulated constantly to complete one problem and try the next!

G.D.

Forthcoming Events.

FRIDAY, JANUARY 29.

S.C.I. *Edinburgh and East of Scotland Section.* Joint meeting with the Glasgow Section of the Society of Chemical Industry and the Edinburgh and East of Scotland Section of the Institute of Chemistry, 36, York Place, Edinburgh, at 7.30 p.m. "Liquid Fuels, To-day and To-morrow," by Dr. A. E. Dunstan.

S.C.I. *Glasgow Section.* Joint meeting with the Edinburgh and East of Scotland Section. (See above.)

INSTITUTE OF CHEMISTRY. Joint meeting with the Edinburgh and East of Scotland Section. (See above.)

WEST OF SCOTLAND IRON AND STEEL INSTITUTE. Central Hotel, Glasgow. Annual Dinner and Dance.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY. Chemistry Section. 36, George Street, Manchester, at 7 p.m. "Trend of Recent Developments in Enzyme Chemistry," by Dr. T. K. Walker.

MONDAY, FEBRUARY 1.

S.C.I. *London Section.* Burlington House, Piccadilly, W.1., at 8 p.m. "Economics and Chemical Manufactures," by H. A. F. Lindsay.

UNIVERSITY OF LONDON. Physiological Theatre, Guy's Hospital, S.E.1, at 5 p.m. Course of eight Lectures on "Use of X-rays in Physiological Investigations." Feb. 1.—"Application of X-rays to the Problems of Growth in Man and the Domestic Animals," by Prof. H. A. Harris. "Application of X-rays to the Problems of Human and Animal Nutrition in Health and Disease with Special Reference to Deficiency Diseases," by Prof. H. A. Harris. Also on Feb. 8, 15, 22, 29, and Mar. 7.

INSTITUTE OF FUEL. Institution of Electrical Engineers, Savoy Place, W.C.2., at 6.30 p.m. Presentation of the Melchett Medal to Prof. W. A. Bone, F.R.S., by the President, Sir Hugo Hirst. "Century of Fuel Economy,"by Prof. Bone.

WEDNESDAY, FEBRUARY 3.

S.C.I. *Montreal Section.* McGill University, Montreal, at 8 p.m. "Explosions in Gases," by Dr. E. W. R. Steacie.

ROYAL SOCIETY OF ARTS. John Street, Adelphi, W.C.2., at 8 p.m. "Geophysical Methods of Prospecting," by A. Broughton Edge.

UNIVERSITY OF LONDON. Bedford College Physiological Department, Regent's Park, N.W.1., at 5.15 p.m. Course of Four Lectures on "Modern Aspects of Nutrition," by Prof. S. J. Cowell. Also on Feb. 10, 17, and 24.

SOCIETY OF PUBLIC ANALYSTS. *Ordinary Meeting.* Burlington House, Piccadilly, W.1., at 8 p.m. "New Method for the Determination of Lead in Organic Substances, with Special Reference to Dyestuffs," by N. L. Allport and G. H. Skrimshire. "Rapid Method of Dissolving Lead Alloys Preparatory to the Determination of Tin and Antimony," by B. S. Evans. "Phloroglucinol Method for the Determination of Mechanical Wood Pulp in Paper," by H. B. Dunnicliff and H. D. Suri. "Investigations Relating to Milk Standards under the Burma Food and Drugs Act," by E. H. Bunce. Informal Dinner, 178, Piccadilly, at 6.30 p.m.

THURSDAY, FEBRUARY 4.

S.C.I. *Bristol Section.* Joint meeting with the Institute of Fuel. University, Bristol, at 7.30 p.m. "Smoke Abatement," by V. R. Chadwick.

CHEMICAL SOCIETY. *Ordinary Scientific Meeting.* Burlington House, Piccadilly, W.1., at 8 p.m.

INSTITUTE OF METALS. *Birmingham Section.* Chamber of Commerce, Birmingham, at 7 p.m. "Dilatometer in the Study of Steels," by N. P. Allen.

INSTITUTION OF ELECTRICAL ENGINEERS. *Annual Dinner and Reunion.* Connaught Rooms, Great Queen Street, W.C., at 7 for 7.30 p.m. Tickets 12s. 6d. each.

FRIDAY, FEBRUARY 5.

S.C.I. *Manchester Section.* Joint meeting with the Manchester Section of the Institution of the Rubber Industry. 17, Albert Square, Manchester, at 7 p.m. "X-ray Examination of Sub-crystalline Materials," by F. D. Miles.

ANDERSONIAN CHEMICAL SOCIETY. Royal Technical College, Glasgow, at 8.15 p.m. "Some Applications of Chemistry in the Dairy Industry," by Dr. N. C. Wright.

PHYSICAL SOCIETY. Imperial College of Science, South Kensington, S.W.7., at 5 p.m.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by permission of the Controller of H.M. Stationery Office and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., price 1/- weekly (annual subscription, £2 10s.).

Latest Patent Applications.

127.—Coley, H. E.—Manufacture of metallic nitrides, etc., from nitrogen. January 2.

128.—Coley, H. E.—Manufacture of cyanides for nitrogen. January 2.

129.—Coley, H. E.—Manufacture of alloys. January 2.

130.—Coley, H. E.—Extraction of gold from arsenical ores. January 2.

131.—Coley, H. E.—Reduction of carbonated, etc. January 2.

Specifications Published.

364,042.—Triggs, W. W. (Du Pont de Nemours and Co., E.1.)—Methods of producing benzanthrone.

363,048.—Imperial Chemical Industries, Ltd. (Du Pont de Nemours and Co., E.1). — Manufacture of sulphide blacks.

364,040.—Dreyfus, H. — Manufacture of acidylated aromatic amines.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

Group Abridgments can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., either sheet by sheet as issued on payment of a subscription of 5s. per Group Volume or in bound volumes, price 2s. each.

359,074.—Alumina; Phospharus; phosphoric acid. I. G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany.

Technically pure fused alumina is obtained, together with phosphorus, by reducing mineral aluminium phosphate in the electric furnace with sufficient carbon not only for the reduction of the phosphorus pentoxide but also for the substantially complete reduction of the gangue, the reaction zone being maintained at a temperature above the melting point of alumina and thus high enough to permit of the decomposition of any metallophosphorus alloy formed by the silicon produced by the reduction of the gangue. The alumina may be drawn off by tapping or allowed to accumulate in the furnace in the form of blocks. When treating aluminium phosphates low in iron it is advisable to add an amount of ferric oxide of iron sufficient to assure the formation of an alloy between *the iron and the elements reduced from the* gangue. Specification 14962/88, (Class 90, Non-metallic elements), is referred to.

The Specification as open to inspection under Section 91 (3) (*a*) comprises also the production of phosphoric acid by the admission of air to oxidise the phosphorus formed in the process, and suitable treatment of the pentoxide so formed. This subject-matter does not appear in the Specification as accepted.

The Latest Trade Marks

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of His Majesty's Stationery Office.

DAG.

527,336.—All goods in Class I which includes chemical substances for use in manufactures, photography or philosophical research and anti-*corrosives.*—E. G. Achesen, Ltd., 40, Wood Street, Westminster, London, S.W.1. January 13. (Associated.)

GARDIOL.

527,880.—Chemical substanees included in Class 1, for use in the treatment of textile fabrics and leather in the course of their manufacture.— H. Th. Bohme Aktien-Gesellschaft, 29, Moritzstrasse, Chemnitz, Germany. January 13. (Associated.)

SPINSTERINE.

527,209.—Chemical substances used for veterinary purposes.—Walter Salberg, 9, Clarges Street, London, W.1., and Claude Eagles Willoughby Beddoes, Ia, Beauchamp Place, London, S.W.3. January 13.

THE CHEMICAL NEWS

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THE PROTECTION OF SCIENTIFIC PROPERTY.

By JULIUS GRANT, M.Sc., Ph.D., A.I.C.

It is a truism that the academic discovery of to-day is the industry of tomorrow, and the history of science provides thousands of examples to illustrate it. Workers in every corner of the earth are continually making contributions to knowledge which bring them no reward other than that resulting from prestige, but which may be developed after a few years or even after a generation into commercial propositions. This vast output of "scientific property," as it may conveniently be called, receives no protection of the kind available for more material goods and ideas. The mathematical genius of Clerk Maxwell revealed the existence of electromagnetic waves, Hertz proved it and Branly and others showed how such waves could be detected, but it was Marconi who, by building on these foundations, was able to exploit wireless for financial purposes. No one will deny the greatness of Marconi's work, but it differed from those of his predecessors in that it involved the invention of a new manufacture, and was therefore patentable. The result has been the development of a world-wide important and prosperous industry hedged in on all sides by patents, none of which however protect the discoveries of the pioneer workers.

The injustice of such a system is obvious, though men such as Clerk Maxwell would probably have been the last to protest against it. Services rendered to the community whether inventive or academic in character are essentially equivalent in value and deserve to be requited to equivalent extents. Few will deny the justice of these contentions but fewer still would venture to suggest means by which the injustice might be righted. Congratulations are therefore due to J. Hettinger who in an article in the current "Science Progress" (1932, *26*, 449), has made a gallant attempt in this direction. The author invites discussion, and although considerable temerity is required to meet a patent expert on his own ground, the prospect of learning how he intends to overcome certain obvious difficulties provides a great temptation.

It is first essential to give a brief outline of the plan (which incidentally is intended to supplement or modify the "Report on Scientific Property" recently submitted by Senator Ruffini to the Committee on Intellectual Co-operation of the League of Nations), without, however, interfering with current international patent systems.

(1) In the first place, the subject-matter of scientific property is defined as intentional or chance discovery of "any new phenomenon, fact or property." This may be protected only if, (*a*) no application to manufacture is obvious at the time; (*b*) if such application is likely to arise subsequently. The definition thus refers to the class of original work falling between theories and inventions, both of which are excluded, whilst discoveries such as those of a new planet are eliminated by (*b*). (*c*) The important clauses are, however, that the owner shall have no claim before the discovery has become capable of exploitation, and that all subsequent important work and which "really advances" the same subject shall also constitute proper subject-matter for scientific property. Naturally enough, claims respecting scientific property should be valid only if the resulting commercal application is patentable in the usual sense of the term, as otherwise conflicts between owners of patents and scientific property might arise.

(2) In order to avoid complications and the resulting heavy expenses, it is suggested that applications for protection should be formal, and that publication of the work in one of the appropriate scientific journals should serve as a "specification"; in such circumstances no examination by the patent officers would be required. A period of 3-6 months between publication and application is suggested, the period of validity being the interval between the dates of application and exploitation as a patentable process plus 16 years, the total not exceeding 25 years. This allows maximum periods of 9 years for the process to be developed, and 16 years (the usual period, but extendable in accordance with the current patent regulations) for the receipt of any financial benefits.

(3) It is intended that scientific property shall be assignable, and that in the interest of technical advance everybody should be entitled to use it without any handicap, unless of course it has reached the patentable stage, when a royalty should become payable. Where a number of investigators are concerned, the royalties should be divided accordingly.

(4) Again, in the interests of economy it it necessary that legal proceedings against the validity of scientific property should not be instituted until such property is patentable, except of course on the grounds of fraud.

(5) Finally, these privileges should be (*a*) restricted to nationals of these countries to which the plan applies; (*b*) they should be retrospective over (say) 5 years.

It must not be imagined that this brief sketch does full justice to Mr. Hettinger's scheme; it summarises however, the essential points, and this is all that space allows. Destructive criticism of the ideas of others is always comparatively easy and constructive replies are correspondingly difficult, but in that case these surely are the respective functions of the scientific worker and patent expert.

Perhaps the most formidable though unwitting enemies to the scheme would be the very persons it is intended to protect, namely workers in pure science. It is almost proverbial that with a few exceptions they are men whose work is undertaken for its own sake. Thoughts of the possibility of pecuniary gain in the future are farthest from their mind when they are creating "scientific property" and the very procedure of applying for protection for it would certainly prove distasteful. The result would be that the most fundamental scientific work would be exploited for protection purposes by less unsophisticated subsequent workers, or probably, by firms employing laboratory staffs, whilst the originator would still remain unrewarded. It therefore seems desirable that acceptance for publication by a reputable journal should automatically serve as protection. Fees however small (though of necessity scarcely negligible), and the formality of making applications would thus be avoided, and the worker, who would be protected willy-nilly would be required only to make claim for his royalties when they became due.

Difficulty would probably be experienced in interpreting some of the terms used. The definition of scientific property given in (1) for example is very wide, perhaps intentionally, and the terms "exploitation" and "really advances" in (1*c*) are equally vague. Hettinger appreciates this and submits that decsions could be arrived at in a Court of Law on evidence, in just the same way as in decisions as to what constitutes invention. The objection here is however, that trouble and expense would be involved but for a prospect of financial gain much more remote than for an invention, and this again would prove a deterrent to the scientific worker.

Another point on which the author's opinion would have been of interest concerns the status of the scientific worker as an employee. Few are in the fortunate position of being able to prosecute research work at their own expenses and, as already pointed out, those that can do so would probably not bother about securing a portion of the profits resulting from not-altogether obvious future commercial applications. The great majority however, are employed by institutions such as universities and research associations and presumably (and justifiably) the scientific property, once acquired, would pass from the hands of the servant to those of the master. This of course is already the case with trade research associations who also command the services of patent experts to enable them to take the fullest advantage obtainable as a result of protection. Universities however exist essentially for the promotion of knowledge (as distinct from manufactures), and their position under the new plan would require some consideration.

With reference to the conditions of subject matter for scientific property (1 *a* and *b*), these two clauses appear to some extent contradictory, and even (in view of clause *c*) redundant. The very fact that the application to manufacture of a new discovery is not obvious (clause *a*) might prevent the assessor from granting protection on the grounds of clause (*b*). The reasons given by the author for the inclusion of these two separate clauses appear sound and fair enough, but if (as according to clause *c*) no claim can be made "until the discovery has become capable of exploitation" it surely is of little importance to define the subject matter so rigorously as to exclude discoveries whose practical applications are either non-existent or obvious. If a discoverer wishes to protect useless materials at his own expense that is his own concern. Another argument in favour of the simplification of these definitions is the great difficulty (greater than for a patent application and requiring assessors of high academic

qualifications) in deciding whether an application is valid.

The difficulties of awarding owners of scientific property their fair royalties would be great, though not insurmountable, but might lead to expensive law suits. Wireless telegraphy and electrical manufactures are examples of important industries based on a century of work by a chain of investigators in all parts of the world from Clerk Maxwell and Faraday, respectively, and it woud be a difficult and invidious task to arrange their work in order of merit for the purpose of financial reward. One might even conceive cases where the number of claimants for royalties is so great that the manufacture could not be developed profitably except at a prohibitive selling price; and on the other hand, cases where the division and sub-division of royalties would leave a negligible amount per individual.

In conclusion it should again be pointed out that these criticisms should in no sense be interpreted as antagonistic to the principle of the plan. They are merely some random thoughts which arise on reading it, and its proposer whose legal mind is probably already tuned to such difficulties will appreciate that any scheme worthy of support is worthy of and must stand the fullest discussions.

Vitamins as Necessities for Life.

By SIR FREDERICK GOWLAND HOPKINS, F.R.S.*

" An error in food, and an error in kind not in quantity, has led to results which have been a scourge to humanity throughout the ages. The full significance of this is not always recognised and has often been forgotten even in medical thought.

"The inadequacy which leads to scurvy is, however, far from being the only error in a food supply which may lead to serious failure in health. The history of rickets tells of much suffering in the young and of much adult disability, and, with interesting associations, the cause of rickets is a fault in diet. Beri-Beri is a fell disorder which has taken toll of thousands among peoples whose basal food is rice. It results when by artificial treatment the rice grain has been deprived of an essential constituent. Pellagra to-day ravages folk in Southern districts of America and is due to an error in their customary food. I have not exhausted the list.

" The onset of each of these maladies is the absence of a vitamin from the food supply. This claim implies that a definite tangible substance, though called for in quantities that are astonishingly small, is wholly necessary for adequate nutrition. The substance lacking is specific in each case; that which protects from others, and, so far as known, nothing else can take its place in affording such protection. To each of these specific substances the name vitamin is now to be applied. The quality that most distinguishes each one of them is that just mentioned. Its functions are indispensable but fulfilled by an amount which is infinitesimal. This characteristic brings each vitamin into a nutritional category differing from that in which we should place the main constituents of food. The material daily needs of the body for the growth and maintenance of its structures is to be thought of in terms of ounces, and its needs for the foodstuffs which provide fuel for its mechanical activities in terms even of pounds. Its need of vitamins, though in the ultimate issue that need is just as urgent, may be reckoned in minute fractions of a grain.

" Before trying to tell you what vitamins are it may just conceivably be well, to place, in parenthesis, a little emphasis on what they are not. Quite recently a colleague, whose tastes and avocations are literary, said to me with a *naiveté* which literary men are apt to assume when referring to scientific matters, but also, to say the truth, with a touch of contempt : ' I hear that, after having made so much of these wonderful vitamins, you and others have since found that they are present in ordinary foods and that we consume them at every

* From the First National B.B.C. Broadcast of the Year, Friday, January 22. Sir Frederick Gowland Hopkins is the first Professor of Biochemistry at Cambridge, which makes his remarks all the more interesting.

meal.' My colleague is a historian who had got this little bit of history wrong and it would have been easy to set him right. I quote his remarks, however, because it would seem that some few others have been under the misapprehension which led to them. But vitamins, of course, are not agencies which science has discovered in mysterious places, or made *de novo;* nor are they capable, when administered, of producing supermen or even super-babies. They are natural substances which, as we gradually learnt in the last few years, are somewhat irregularly distributed among natural foodstuffs; but, as I think all will admit after due consideration of the facts, this does not in the least detract from the practical importance, and certainly not from the scientific interest, of the recent realisation that they so exist.

"When I was a medical student an orthodox treatment of scurvy (apart from rest in bed) was the administration of somewhat heavy doses of potassium salts, or of citric acid. This was at any rate based upon a recognition of the circumstance that these substances are present in the fresh fruits which so long before had been proved sovereign remedies for the disease. But it was not because they contained potassium or citric acid that the fruits were curative. I remember a happening during my student days which much impressed me. Scurvy was then rare in a London hospital as it is rare now, but it happened that two suffering sailors from the same ship were admitted into the ward to which I was attached. As part of their treatment they were given large doses of potassium citrate but although their diet in hospital was doubtless better than that on board it was for them not ideal and progress was very slow. Now on a certain visiting day the relations of one of these patients brought him a few oranges, and, though such introductions of food from without were commonly and rightly forbidden, he was happily allowed to consume them. The symptoms of this patient immediately began in most dramatic fashion to clear up and in ten days or so he was practically well, whereas the less fortunate patient was displaying the slowest of progress. This happening in the ward, an affair of long ago, but which I could never forget, was of the nature of a controlled though unintended experiment, controlled because a single factor alone distinguished two cases. Now the circumstances of the two patients were identical save for the consumption of a few oranges by one of them. His cure must have been due to a constituent of the orange but it was certainly not potassium citrate as that was given to both patients. Not till some fifteen years afterwards did it become clear that it was a constituent of which the amount is probably not more than one ten-thousandth of the whole orange. We should now call it Vitamin C.

"The special characteristic of Vitamin C is its instability. It is destroyed by heat at moderate temperatures, and by exposure to the air, as when vegetables and fruits are dried. This instability has played, of course, a large part in the history of scurvy. The vitamin is most stable in acid solutions, and this is why orange, lemon and lime juices, which contain relatively large amounts and are acid, are so valuable for those who risk long separation from fresh foods. From such sources many efforts are being made to separate the pure vitamin itself. It is not difficult to obtain it in a highly concentrated form. I myself have recently handled a preparation which in daily doses of 1/6000th of a grain rapidly and completely cured animals suffering from severe scurvy as a result of deficient dietary. In this preparation, however, the vitamin was still mixed with inactive impurities. But news has recently come from Norway which suggests that the actual vitamin has there been isolated and its actual nature indicated. Strange to say it would seem to be closely allied to Narcotine, a substance known previously as occurring in opium. It is interesting to realise, and of this I think we may be sure, that an ounce of the pure Vitamin would protect at least five thousand human beings from scurvy for a whole year, whatever their food. To obtain that quantity with our present powers would probably require some millions of oranges or lemons; but be assured the day is not so far distant when the organic chemist will make it, as well as other vitamins, artificially.

"I may next mention the vitamin which is labelled B. It is this which protects from the disease Beri-Beri and is necessary for the proper nutrition of the nervous system. To its separation from yeast, which happens to be rich in it, many efforts have been directed. Only a few days ago did we learn that in Germany it has now been isolated as

a pure crystalline substance and a point of interest would seem to be that the element sulphur plays a part in its constitution. Quite extraordinarily small is the dose which will cure severe symptoms in an animal.

"Of Vitamin D, which prevents and cures rickets, I am eager to tell you at once that, simultaneously in this country and in Germany, it has been isolated and prepared artificially. This highly satisfactory accomplishment has been reached along a most interesting path. It has been known for some few years that associated with animal fats, and in particular with fats stored in the livers of various animals, in cod liver oil for instance, is a vitamin which prevents and cures rickets; but it had been further shown that sunlight also cures that disease. Later it appeared that a substance, a sterol so-called, exists in most animal and plant tissues which, itself inactive, becomes converted into the active vitamin under the action of the ultra-violet rays which are present in sunlight. It thus became pretty clear that sunlight cures because it increases the amounts of vitamin in the body. By artificially irradiating its inactive precursor, which is easily obtained, the vitamin can be now produced in relatively large amounts, and from such material by ingenious methods it has now been obtained pure. I have seen a specimen of the first product made commercially, a beautiful crystalline substance, which, with its temporary alphabetical label discarded, is to be known as Calciferol. Its activity is very great. Two grains would be more than sufficient to cure severe rickets in some four hundred thousand young rats. An ounce would provide a daily ration adequate to protect some million children from the malady. Apart from its control of rickets this vitamin consumed in right amounts exerts a favourable influence on the development of the teeth, and, as carefully controlled observations on school children in this country has shown, aids in the arrest of caries.

"Another vitamin which like D was first known in association with animal fats, is Vitamin A. Recent work has brought us within measurable distance of knowledge of its exact nature. Without it growth is impossible and degeneration of important tissue elements occurs in the body. There is, moreover, growing evidence to show that an adequate supply of it protects from bacterial infections. Confirmation and consolidation of this will give to Vitamin A very great practical value. You may well enquire at this point how agencies so potent in small amounts will affect the body in larger amounts. Recent research has shown that, in the case of Vitamin D at any rate, harm may result from excess. But so great is the difference between a right and a wrong amount that there is little to fear from this circumstance.

"It is not too much to say that but a fraction of humanity has ever enjoyed really optimal nutrition; and that fraction has comprised only the well-to-do in highly civilised communities. It is for the comfortable classes to say to-day: 'Life would be a burden if we have to bother about these details in our food; let us enjoy what we like and take our chances.' This is an entirely commendable attitude—for the relatively wealthy. But as a matter of fact realisation of the nutritional importance of vitamins or of any kindred circumstance does not for the majority call for much self-conscious concern about food. Social and economic policy, consciously or subconsciously, reacts to fresh knowledge, and the individual may then benefit unconsciously. At the present moment the enterprises which are making fruit plentiful all the year round, and the development of dairy farming (though this it is hoped may go farther) are illustrations of this. For to say the truth, although the list of vitamins seems formidable, yet, the majority of folk, even in ignorance of detail, have learnt during the last ten years, the consumption of fruits, fresh vegetables and sound products from the dairy, goes a long way, if not quite the whole way, towards securing an adequate vitamin supply. Those who live even at a moderate economical level, probably all who now pay income tax, do usually thus secure it. Yet one must not go too far in suggesting for anybody an attitude of unconcern about these matters. All of us are citizens wishing that ours should be a healthy nation. We have to think of the nutrition of the poor, and of that of the infant in all classes. If you should have the opportunity of appraising the food purchases of the housewife in a family of low earning power, you will find that the amount of sound animal fats

which she obtains is far too small. Such fats are relatively the most expensive of foods and the amount purchased always falls with a fall in wages. These fats are valuable in themselves but what we should here remember is that with them the supply of the Vitamins A and D is acquired. Children and young adolescents promptly suffer from a lack of these. Those who get too little will show deficient growth, will make poor bones and teeth, their health will be subnormal and it is probable at least that they will become more than ordinarily prone to infections. It is important that this kind of depressed health should be more widely recognised as nutritional rather than constitutional. Every fall in the purchasing power of the pound would tend to increase its prevalence at certain economic levels."

The Chemistry of the Conversion of Algæ into Bitumen and Petroleum and of the Fucosite-Petroleum Cycle

By J. E. HACKFORD, B.Sc., F.I.C.

Member of The Institution of Petroleum Technologists.

(*Continued from page* 69.)

The Acid Hydrolysis of Seaweed Residues.—In order to ascertain whether oil could be obtained from the dried seaweed residues remaining after their exhaustive extraction in the autoclave as described, 100 gms. of the dried weed were hydrolysed for a period of four days with one litre of a 5 per cent. by weight solution of sulphuric acid, then filtered through a Buchner funnel.

44.3 gms. of residue remained, and the balance of 56.7 gms. was dissolved in the acid filtrate. Both the residue and filtrate were extracted with chloroform, which dissolved out the oil formed during hydrolysis. The following results were obtained :—

Solvent.	Residue.	Acid Filtrate.
Chloroform	3.6 gms. oil	0.84 gms oil

The Nature of the Products of Acid Hydrolysis of Algæ.

1. *The Brown Bituminous Substance Algarite.*—It is proposed for convenience to call this brown precipitate " Algarite " for reasons which will be explained later.

After seven days acid hydrolysis the two-hour alkaline extract of seaweed, a total weight of 5.55 gms. were obtained from 12.81 gms. of soluble seaweed material; equivalent to a 43.2 per cent. yield. The ash content consisted mainly of calcium sulphate, which amounts to 0.6 per cent. in algarite washed with excess of boiling hydrochloric acid. In freshly precipitated algarite the ash content is 8.9 per cent.

Algarite is a brown amorphous powder, which appears yellow under the microscope and shows no sign of structure. It is very sparingly soluble in ethyl and amyl alcohols, and is insoluble in ether, carbon disulphide and chloroform. Algarite, as formed during hydrolysis at 100° C., is partially soluble in pyridine (24.8 per cent.) (c.f. algarose) and this soluble portion has all the characteristics of a bitumen, particularly that class known as the keroles. The insoluble portion also resembles some classes of bitumen, and in particular a bitumen called McKittrite, which is described later. Algarite is readily soluble in a dilute soda solution, from which it is almost entirely reprecipitated by acids, as a dark red powder, possessing acidic properties. It appears to be the acid of a body related to the fucose-pentosans, for on hydrolysis with soda it reduces Fehling's solution and yields osazones with phenyl hydrazine acetate. It is not yet proven that the substance is a pentosan, but at this stage it is only assumed to be a pentosan by analogy with a seepage bitumen having similar properties which yields the pentose arabinose upon hydrolysis. (See sample No. 6.) Upon dry distillation oil is evolved in quantities (45 per cent. yield) while traces of both hydrogen sulphide and ammonia are evolved. The oil so evolved contains appreciable amounts of tertiary amines as shown by the tungstic acid test, while phenols were present in the alkaline wash. The odour evolved during dry distillation is that of burnt feathers. Algarite is also slightly soluble in hot water

and dilute acids, and after prolonged acid hydrolysis traces of oil can be extracted from the liquors by chloroform.*

Being partially soluble in pyridine but insoluble in chloroform or carbon disulphide, algarite must be classified as a kerole and, on account of the low sulphur content, the classification can be carried one step further —it is an oxykerole.

The Ethyl Alcohol Precipitate.—This material is described by Haas and proved to consist of the calcium salts of the ethereal sulphonic esters. The ash consists mainly of calcium sulphate. When dry, the material is a light brown amorphous powder, soluble in both dilute acids and alkalis as well as in water. Upon hydrolysis, it yields sulphuric acid, calcium sulphate, and a dihydric alcohol, which upon further hydrolysis forms tertiary amines as proved by the tungstic acid reaction, and ultimately yields oil and sugars. The progress of the decomposition is shown in the table " Acid Hydrolysis."

The Tungstic Acid Precipitate. — This material consists of a black amorphous powder soluble in acetone. The nitrogen present is in the form of tertiary amines, and also, probably, as the ammonium salt of a sulphonic ester, because upon boiling with alkali ammonia is evolved.

Upon boiling with strong caustic soda (33 per cent.) a dark coloured oil is liberated.

If the tungstic acid precipitate be dissolved in ammonia and reprecipitated by the addition of hydrochloric acid, tungstic acid is thrown down, and after filtration a brown solution remains which, upon evaporation, gives an oily residue, soluble in ethyl and amyl alcohols, but insoluble in chloroform, benzene, and carbon disulphide.

The Ammonia Precipitate.—This precipitate was obtained by neutralising the acid solution with ammonia. It is a black amorphous powder, which decomposed on drying in the water oven yielding an oil soluble in chloroform. It is only partially soluble in ether and petroleum ether, the insoluble residue having the properties of asphaltenes.

The Oil.—The oil was obtained from the acid solution by extraction with chloroform, and amounted to practically 10 per cent. by weight of the total solids originally present in the solution. This, however, is not a true measure of the amount of oil that could have been obtained had hydrolysis proceeded still further. Nor does this amount of oil represent all that can be obtained from the aqueous extract, for, as recorded, both the tertiary amines and the ammonia precipitate can be made to yield their quota of oil. Under the microscope the acid solution appeared to contain the oil in an emulsified form. The oil was a deep, lemon yellow viscous liquid, having the appearance of a heavy spindle oil. It was fairly stable towards strong sulphuric acid. It was partially soluble in caustic soda solution showing the presence of the naphthenic acids, and was totally soluble in ethyl ether, petroleum ether, carbon disulphide, and chloroform.

The percentage of naphthenic acids represented 21.8 per cent. of the total oil, and were of a reddish-brown colour and liquid at normal temperatures. The remaining hydrocarbon oils (78.2 per cent.) were stable to sulphuric acid.

The Sugars.—As a relatively large amount of sugars remained in the acid solution after hydrolysis, experiments were made to ascertain if the sugars themselves played any important part in the formation of either oil or bitumen, even though this seemed unlikely. At the same time, the hydrolysis of sucrose by acid, with the formation of glucose and fructose is well known, as is also the production of water soluble ketonic acids such as pyruvic and laevulinic acids.

In the first experiment 100 gms. of sucrose were placed in a flask with 250 ml. water and 10 ml. of sulphuric acid and boiled under a reflux condenser. After half an hour the solution darkened and a skin of a semi-plastic asphaltic looking material formed on the surface of the liquid. After hydrolysing for 24 hrs. this substance became harder, and by appearance it resembled the char obtained by the action of strong sulphuric acid on sucrose; 15 gms. were obtained after filtering off, washing with water until neutral, and subsequently drying.

* Haas and Wells[16] noted the formation of the brown amorphous powder during the acid hydrolysis of seaweed in 1928, but the yield was small owing to the short not examined.
time of hydrolysis, and the substance was

The precipitate was not, however, a purely carbonaceous mass, as it was partially soluble in pyridine; 5.01 gms. giving 1.17 gms. of soluble material, equal to a 23.4 per cent. yield. This pyridine soluble fraction dissolved in chloroform, alcohol, ammonia, and caustic soda solution, and was partially soluble in ether. It contained no sulphur. After being dissolved in caustic soda the substance rapidly reduced Fehling solution.

The filtered acid liquors were a dark brown colour, and after repeated extractions with chloroform a water-insoluble red oil was isolated, amounting in all to 5.9 gms.

After the isolation of the oil a portion of the remaining acid liquor was placed on the water bath and allowed to concentrate. As the acid grew stronger the mass became blacker and blacker, resulting in a quantity of a rubber-like material gelatinous to the touch as it also was in appearance, and resembled fucosite after it had swelled in water.

An excess of lime was added to another portion in order to neutralise the free acid and to form the calcium soaps of the gelatinous-like material mentioned above. Lime was chosen both on account of the natural occurrence of calcium salts in contiguity with the oil and seepages described later, and also on account of the fact that algæ contain such a large amount of lime in their inorganic constitution.

After drying on the water bath, the above residue was placed in a flask and heated at 110° C. for one week. Water, but no oil was evolved. When this thoroughly dried residue was heated in an ignition tube a reddish-brown oil was given off with every appearance of the oils from the seepages described in section 2 of this paper. The odour was that of burnt feathers which was remarkable because no nitrogen was present. Neither the cane sugar, the sulphuric acid nor the lime contained nitrogen. This explains the reason of the burnt feather odour of the oils evolved on heating these seepages, which contained only normal amounts of nitrogen; *e.g.*, the fucosite described later only contained 1.72 per cent. N., but on heating evolved a strong characteristic odour of burnt feathers.

On account of this similarity, another experiment was undertaken to ascertain if this precipitate could not be obtained in an uncharred condition, and also to see if it resembled algarite because of the similarity in behaviour to pyridine and other solvents.

One hundred gms. sugar, 300 ml. water, 100 ml. sulphuric acid, and 400 ml. chloroform were placed in a flask under a reflux condenser and heated so that the chloroform was just kept boiling, whereby the temperature of the contents of the flask was maintained at the boiling point of the chloroform, *viz.*, 61° C. At the same time, the products of reaction were removed by the condensed chloroform vapour from the sphere of chemical action and so preserved from the further action of the acid. Under these circumstances the precipitate appeared as a flocculent red-brown feathery substance, and simultaneously the chloroform became firstly a light red, and finally a dark red-brown colour, as it dissolved the oils formed. After the first day the whole was filtered through a large Buchner funnel and the precipitate dried and weighed. The chloroform extract was separated from the acid liquors in a separating funnel, washed with a little water, distilled in a weighed flask, thus giving the weight of the oil formed. This procedure was repeated daily and the following results obtained :—

	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day	8th day	Total
Wt. of algarose ...	0.27	2.34	2.11	0.44	1.56	0.23	0.27	0.1 approx.	7.52
Wt. of oil in gms.	1.006	4.5	2.87	1.6	4.21	2.26	1.21	0.57	18.126

The Properties of Algarose.—This precipitate, to which it is proposed to give the generic name "Algarose" may be taken to be a pure form of Algarite, both as obtained from seaweed and from naturally occurring seepages, such as exemplified in McKittrite (Sample No. 6). The termination "-ose" indicates its relationship to the sugars. It differs in some respects from algarite inasmuch as it may be considered a chemically pure bitumen, if not a synthetic one, as it has been prepared from a substance of known constitution. It contains neither rare elements, tertiary amines, ammonium salts, calcium salts of the ethereal sulphonic esters, nor sulphur.

As freshly precipitated from low temperature solution algarose is a red-brown powder wholly soluble in pyridine, ammonia, caustic soda, and alcohol, but after drying or beating in the water oven for a few hours it firstly comes only partially soluble, and finally insoluble in these solvents. The solution in caustic soda readily reduces Fehling solution, as also does the aqueous or sligbtly acid solutions in which algarose is sparingly soluble. If, after drying, it be attempted to dissolve algarose in an aqueous or soda solution, it swells up to a rubber-like mass increasing its volume two or three times as does the fucosite of Samples Nos. 1, 2 and 3.

Upon dry distillation vapours are given off which condense as a red oil. The smell resembles that of burnt sugar in the first place, but later the biting smell of pyruvic acid disappears and the odour more nearly resembles that of some asphaltic residues. A residue of carbon remains.

As algarose is soluble in alkalis, from which solutions it is reprecipitated by acids, its nature is acidic. It has not yet been ascertained whether this acidity is due to the presence of a carboxylic group, or whether it is due to the ketonic formation

$$—CO.CH_2.CO—$$

neither has it been ascertained whether its power of reducing Fehling solution is due to the presence of an aldehyde or of the ketonic grouping

$$—CO.CH_2OH$$

as occurs in fructose.

Upon oxidation with nitric acid, a crop of crystals was obtained which were colourless prisms melting at 100°C., and which, when dissolved in water, precipitated an ammoniacal solution of calcium chloride. They were therefore oxalic acid.

The Properties of the Oil derived by the Acid Hydrolysis of Sugar (Sucrose).—The oil is a dark red liquid, very similar in appearance to the oil and asphaltene fraction of McKittrite. It is acidic in character, dissolving in caustic soda solution and also in ammonia, with considerable darkening in colour. On acidification a brown-red precipitate is thrown down similar in appearance to algarose. Whether this change in physical properties is dne to tautomerism or to polymerisation is at present unknown.

On heating in the water oven algarose becomes insoluble insolvents and here the change may also be similarly due to tautomerism. The oil is not a pure chemical substance, but a mixture containing :—

	%
Unsaponifiable matter ... ... (A light coloured oil of waxy appearance).	1.20
Asphaltenes ... ... (Soluble in CS_2)	1.12
Kerotenes ... ... (Soluble in $CHCl_3$)	14.28
Oil ... ... (Soluble in ethyl ether)	83.40

The oil is soluble in alcohol, chloroform and pyridine, and is sparingly soluble in carbon disulphide, water, and dilute acids; it is insoluble in petroleum ether. It is readily soluble on alkalis, and this solution reduces Fehling solution. (These characteristics are similar to those of the asphaltene fraction of McKittrite.)

If, however, the oil be first dissolved in ammonia and evaporated to dryness on the water bath, the resultant mass is a dark brownish black coloured solid, fairly soluble in water; this aqueous solution does not reduce Fehling. In this respect tbe formation of ammonium salts during the hydrolysis of seaweed is of importance; 14 gms. of oil were distilled at atmospheric pressure, with the following results.—

Initial boiling point	82°C.	
—100°C. ...	0.5 ml. = 3.5	per cent.
100—200°C. ...	1.1 ml. = 7.2	,,
200—220°C. ...	6.3 ml. = 45	,,

At 220°C. the residue suddenly changed into a solid form (44.3 per cent.), insoluble in soda and pyridine.

The 6.3 ml. fraction was 40 per cent. soluble in soda, and like the original oil the addition of acid caused a brown solid precipitate to be thrown down. The remaining 60 per cent. of this oil was soluble on strong sulphuric acid.

As the oil was totally soluble in soda before distillation, it is evident that an intramolecular change has taken place. The acidity may have been destroyed either by the elimination of the carboxylic group —COOH or by the tautomeric change

$$R—C(OH)=CH—CO \rightleftarrows R—CO—CH_2—CO—$$

These hydroxy acids are not difficult to reduce. The classic example is the reduction of all the >CH.OH and —CH_2OH groups by means of hydriodic acid and amorphous phosphorus.

$$CH_2OH.(CH.OH)_4.CH.OH.COOH+12HI = CH_3(CH_2)_4.CH_2.COOH+6H_2O+6I_2$$

n. heptylic acid

THE ALKALINE HYDROLYSIS OF THE AQUEOUS EXTRACT OF SEAWEED.

Reagent	Aqueous extract; 1.213 gm. solids per 100 ml.			Aq. extract plus 2 per cent. sodium carbonate after four days' hydrolysis.		
	Weight of precipitate	Organic matter	Ash	Weight of precipitate	Organic matter	Ash
Ethyl alcohol ...	0.3518	0.2530	0.0988	0.1352	0.1240	0.0112
Tungstic acid ...	nil	—	—	0.4584	0.2092	0.2492
Ammonia	nil	—	—	nil	nil	nil
Chloroform	nil	—	—	nil	nil	nil

When the acids were placed in the air-oven at 110° C. for one week, 49 per cent. by weight were converted into a solid material insoluble in both caustic soda and chloroform. In appearance it resembled the insoluble variety of algarose resultant upon the gentle heating of the same at 110°C. for a prolonged period of time. The remaining 51 per cent. consisted of an oily looking substance of an acidic nature as it was totally soluble in soda.

When the acids were heated with calcium chloride under the same conditions, approximately the same amount was changed into the insoluble variety of algarose, but a large part (42 per cent.) of the remainder was an oil insoluble in soda, but soluble in chloroform. The acids had thus been converted into an inert neutral hydrocarbon oil by the agency of a material — calcium chloride — which is found associated with oil in nature.

The oils firstly obtained from the sugars are soluble in soda and have the properties of carboxylic acids, but readily decompose, yielding oils insoluble in soda and stable to sulphuric acid; the oils then possess the properties of hydrocarbon oils. In the same way the oil obtained from the acid hydrolysis of the algæ contained 21.8 per cent. of acids, which are indiscriminately called carboxylic or naphthenic acids by custom. During decomposition it is to be expected that the carboxylic group would decompose with the evolution of carbon dioxide. In this respect is is interesting to note that the gases obtained from the oil wells of the district are characterised by their large carbon-dioxide content.

ANALYSES OF NATURAL GAS FROM THE WESTERN PART OF THE SUNSET-MIDWAY FIELD.

	% CO_2
1. Chanslor-Canfield Midway Oil Co., well 6, sec. 31, T31S..R.23E. Gas associatedwith oil of 22°B. gravity, chiefly in zone C. Sampled by G. S. Rogers, July, 1914, analysed by G. A. Burrell, Bureau of Mines ...	19.7
2. Hawaiian Oil Co., well 1, sec. 31, T31S., R.23E. Sampled by I. C. Allen, July, 1914; analysed by G. A. Burrell, Bureau of Mines ...	10.5
3. Hale-McLeod Oil Co., well 5, sec. 8, T32S., R.23E. Gas associated with oil of 17° B. gravity in zone A. Sampled by G. S. Rogers, July, 1914; analysed by G. A. Burrell, Bureau of Mines	20.0
4. Indian and Colonial Oil Co., well 28, sec. 22, T32S., R.23E. Gas associated with oil of 14° B. gravity in zone A. Sampled by G. S. Rogers, July, 1914; analysed by G. A. Burrell, Bureau of Mines	9.8
5. Kern Trading and Oil Co., wells in sec. 31, T12N., R.23W. Gas associated with oil of average gravity of 21° B. in zone B. Sampled and analysed by W. E. Perdew; authority, Kern Trading and Oil Co.	22.8
6. Topaz Oil Co., well 3, sec. 18, T11N., R.23W. Gas associated with "shale oil" of 17° B., gravity in zone B. Sampled byG. S. Rogers, July, 1914; analysed by G. A. Burrell, Bureau of Mines	24.2

7. Spreckels Oil Co., well 5, sec. 32, T12N., R.23W. Gas from bed 80 ft. above producing oil sand (in zone B). Sampled by G. S. Rogers, July, 1914; analysed by G. A. Burrell, Bureau of Mines ...	20.0

ANALYSES OF GAS FROM THE SOUTHERN PART OF THE BUENA VISTA HILLS, MIDWAY FIELD (T32S., R.24E.).

	% CO_2
1. Honoulu Oil Co., well 7, sec. 4. Gas about 300ft. above top of oil zone B	4.2
2. Honolulu Oil Co., well 1, sec. 6. Dry gas about 200ft. above top of oil zone B. *California State Min. Bur. Bull.*, 1914, 69, 250	7.0
3. Honolulu Oil Co., well 5, sec. 6. "Dry" gas about 200ft. above top of oil zone B. Sampled by G. S. Rogers, July, 1914; analysed by G. A. Burrell, Bureau of Mines	7.6
4. Honolulu Oil Co., well 7, sec. 6. "Wet" gas associated with oil of 31° B. gravity, chiefly in zone C	16.5
5. Honolulu Oil Co., well 5, sec. 8. Gas about 250ft. above top of oil zone B	8.1
6. Honolulu Oil Co., well 6, sec. 8. Gas about 400ft. above top of oil zone B	6.9
7. Honolulu Oil Co., well 7, sec. 8. Gas about 300ft. above top of oil zone B	5.6
8. Honolulu Oil Co., well 1, sec. 14. Gas about 1000ft. above top of oil zone B	7.7

The Alkaline Hydrolysis of the Aqueous Extract of Seaweed. — During the alkaline hydrolysis of seaweed, algarite is not precipitated on account of its solubility in soda. Whether it is actually formed or not is unknown. At the time these experiments were in progress the formation of algarose from sugar had not been discovered, and the importance of looking for the substance had not been recognised.

As in the case of acid hydrolysis, it is found that the calcium salts of the ethereal sulphonic esters were decomposed, tertiary amines being simultaneously formed. Ammonia is also liberated in small quantities, but no neutral oils were formed soluble in chloroform. The sodium salts of the fatty acids did not appear to be present, as nothing was extracted by chloroform after acidification.

The two hour alkaline aqueous extract employed during these experiments was part of the same stock as that employed for the experiments upon acid hydrolysis. The results shown in the table were obtained.

(To be continued.)

JAPANESE SEEKING MARKETS FOR SUPERPHOSPHATES.

The Superphosphates Exporters' Association of Japan has continued its efforts to find new markets abroad for the output of its member companies. Statistics of exports for recent years are not available but it is reported that shipments of about 150 tons monthly have been made to Pacific Coast ports of the United States and of about 100 tons monthly to the South Seas, with occasional shipments to India. The association has recently dispatched investigators to other markets, notably South Africa, with a view toward entering those markets. A movement has also been started to obtain a reduction in the current freight rate of 13 yen per ton from Japan to South African ports.

GERMAN BENZOL PRODUCERS CONTINUE SYNDICATE AGREEMENT.

The annual report of the German Benzol Association, "Bochum," for 1930, recently issued, announces the extension for several more years of the syndicate agreement with the Benzol Vereinigung des Ostens G. m. b. H. of Berlin, representing producers in the Eastern part of Germany. A 15 per cent. production decline as well as decreased sales is reported for the fiscal year. Coincident with this report is the fact that German imports during the first nine months of 1931 declined 30 per cent. to 104,985 metric tons, compared with 149,203 tons in the 1930 three-quarter period.

U.S. PRODUCES $3,500,000 WORTH OF CHEMICAL PRODUCTS.

The value of chemicals and allied products produced by corporations in the United States now aggregates $3,500,000,000 annually, as compared with an estimated value of $816,000,000 in 1913, prior to the World War, Fenner, Beane and Ungerleider point out in a study of the American chemical industry.

I. C. I. CUTS PRICE OF NITRATE OF SODA (SYNTHETIC).

Imperial Chemical Industries (Ltd.), are offering in limited quantities, synthetic sodium nitrate produced at Billingham, at the same price as Chilean nitrate. The January price schedule for sodium nitrate in 6-ton lots is £8 14s. a long ton, February-June, £8 16s. freight paid to any railway station in Great Britain, or c.i.f. Isle of Man main ports, less 7s. 6d. a ton discount. Ammonium sulphate for domestic agricultural purposes is offered in 6-ton lots for January-June, 1932, at £7 a ton, with the same delivery terms as for nitrate.

JAPANESE NOW MANUFACTURING CODEINE PHOSPHATE.

The Japanese Home Department has appropriated 200,000 yen towards the manufacturing of codeine phosphate, after having made the initial success of manufacturing it and selling it to private drug dealers. The Tokyo Municipal hygiene laboratory which has been manufacturing this chemical is exponding its output and the price of the chemical has gone down with no sign of any abatement. A ban has been placed on the importation of this chemical since November 1st last. This step is partly intended as a means of controlling the domestic market and it is expected that the codeine phosphate market will be stabilised in the near future. Some of the manufacturers of codeine phosphate as imported raw material are said to have petitioned the government authorities to establish a permit system of importation.

JAPANESE PROFESSOR ATTEMPTS THE MANUFACTURE OF HELIUM FROM LIQUID HYDROGEN.

Professor Shinichi Aoyama, of the Department of Science in the Tohoku Imperial University, has secured machines for the liquidating of hydrogen and air with the donation of 128,000 yen made by the Saito Hoonkai, from Germany and has completed installing them in the laboratory. He will shortly commence the liquidation of hydrogen for the first time in Japan. Professor Aoyama will use it to study the physical nature of metals. He also hopes to manufacture helium from the atmosphere by means of this chemical at much lower cost than formerly.

THE ESTIMATION OF FREE CALCIUM OXIDE AND HYDROXIDE.

A knowledge of the amounts of hydrated and unhydrated free lime in cements and other building materials is frequently of the utmost importance. The complexity of many of those materials, however, makes the accurate estimation of free lime a matter of considerable difficulty.

Apart from the methods made available or suggested by other investigators, certain methods have been modified or developed at the Building Research Sation. All these methods are reviewed comprehensively in Building Research Special Report No. 17, issued by the Department of Scientific and Industrial Research. Those recommended for use for the various types of materials are set out in detail.

The list of contents of the Report is as follows :—

INTRODUCTION.

General Review of Methods :—I. Qualitative. II. Quantitative—(*a*) Extraction Methods — (i) Aqueous Solutions — (ii) Alcoholic Solutions—(iii) Glycerol : (*b*) Calorimetric Methods : (*c*) Other Methods.

Recommended Methods :—I. Accuracy —(*a*) Glycerol Extraction Methods : (*b*) Lime Solution Extraction Method : (*c*) Calorimetric Method. II. Applicability —(*a*) Unhydrated Materials—(i) Hydraulic Cements — (ii) Hydraulic and Semi-Hydraulic Limes : (*b*) Hydrated Materials — (i) Hydrated Portland Cements — (ii) Hydrated Limes and Lime Mortars—(iii) Cement Mortars or Concretes with Active Additions—(iv) Lime Mortars with Active Additions—(v) Sand-Lime Bricks : (*c*) Other Materials.

SUMMARY.

Appendices—I. Optical Properties of CaO and Ca $(OH)_2$: II. White's Test : III. Lerch and Bogue's Modification of the Glycerol Method : IV. Building Research Station Modification of the Glycerol Method : V. Lime Solution Extraction Method : VI. Calorimetric Method.

MENTHOL CRYSTALS & PEPPERMINT OIL PRODUCTION OF JAPAN.

The output of crude peppermint oil in Japan for 1931 is estimated at 1,180,000 pounds, of which 235,000 pounds came from Honshu and 945,000 pounds from Hokkaido. The output in Hokkaido was somewhat less than previous estimates, which placed the production in that section at 1,040,000 pounds. Insect pests accounted for the decreased yield. The price of crude peppermint oil at Kobe on October 10 was 3 yen per kin (1.32 pounds), which is unusually low. Menthol crystals on the same date were quoted at 5 yen per kin, which was the lowest price known in Kobe during the past 15 years. The drop in price was attributed to the collapse of European exchanges. Stocks of crude peppermint oil in Japan were large at the close of September, amounting to about 200,000 pounds as compared with 195,000 pounds at the end of June, 1930.

SWEDISH GOLD PRODUCTION.

According to recent reports from the Continent rich auriferous ore has been found in the neighbourhood of Skelleftea, Sweden, between the 64th and 65th north latitudes.

The ore is said to contain up to 120 grains of gold per ton. The output by next June is expected to attain 12,000 kilograms so that Sweden will become a producer of some 2 per cent. of the world's annual gold output.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

JANUARY EXAMINATIONS, 1932.

PASS LIST.

Examination in General Chemistry for the Associateship.

Bews, William Fraser, Central Technical School, Liverpool; Lloyd, Douglas Howard, Technical College, Birmingham; Mason, Reginald Dean, B.Sc. (Lond.), Birkbeck College, London.

Examination for the Fellowship.

In Branch B. Physical Chemistry, with special reference to Electrochemistry.

Winterbottom, Arthur Baker, M.Sc. Tech. (Manc.).

Correspondence.

Bergen op Zoom,
Holland.

The Fundamental Difference between Bohr's Model of the Atom and the Chemical Model Developed by me in "The Chemical News" (1928-31).

Dear Sir,

Bohr tries to solve the riddle of the structure of the atoms with the riddle of electric force.

The chemical model gives an atom, which is built up from material units which at the same time are primary centres of force (protons).

An ether-tornado as a primary centre of force in a gaseous ether consisting of extremely fine particles need no more be considered a riddle than an ordinary atmospheric whirlwind. The proton as an ether tornado can thus solve the riddle of the constitution of the atom fundamentally and conclusively. With Bohr, electric force, however, remains unexplained.

Yours truly,

Dr. W. TOMBROCK.

The Editor,
Chemical News.

Notices of Books.

Association Theory of Solution and Inadequacy of the Dissociation Theory. By J. N. RAKSHIT, F.I.C. Pp. iv + 298. Calcutta : S. C. Auddy & Co., 58, Wellington Street.

In this volume Mr. Rakshit has collected considerable data usually overlooked by the exponents of the Dissociation Theory of Solution. The success which attended the exposition of this theory after its enunciation by Arrhenius some 30 years ago has diverted attention from the anomalies in such phenomena as volume contractions upon dissolution, the surface tension, viscosity, osmotic pressure and thermal effects shown by solutions do not all conform to the requirements of the ionic theory, and Mr. Rakshit evidently favours the Association Theory which assumes the formation of hydrates (or other solvent compounds) of the solute.

Whatever views may be held concerning the merits of the two views there can be no doubt that Mr. Rakshit has made a useful

feature of the numerous tables of data which he has compiled in this book. In the section dealing with the viscosities of solutions the author points out that from the figures the gives the viscosity deviates from the average for the components and in order to account for this he suggests that the components must have combined to acquire a property of the solution which differs from that of the solute plus solvent.

The author also criticises the statement by Nernst that osmotic pressure is independent of the nature of the solvent, thus carrying the analogy of the Gas Laws to a climax. Mr. Rakshit also gives at the end of each chapter an extensive bibliography and his book is worthy of the attention of all chemists and physicists interested in the theories of solution.

Forthcoming Events.

FRIDAY, FEBRUARY 5.

INSTITUTE OF FUEL. Technical College, Derby, at 7 p.m. "Industrial Furnace Design," by E. W. Plumley.

SATURDAY, FEBRUARY 6.

S.C.I. *Birmingham and Midland Section.* Midland Hotel, Birmingham. Jointly with the Institute of Chemistry and the British Association of Chemists. Annual Dinner Dance. Tickets. Double 21s. Single, Gentlemen, 12s. 6d.; Ladies, 10s. 6d.

MONDAY, FEBRUARY 8.

INSTITUTE OF METALS. Scottish Section. 39, Elmbank Crescent, Glasgow, at 7.30 p.m. "Aluminium Silicon Alloys—Their Properties and Some Applications," by R. B. Deeley.

GLASGOW UNIVERSITY ALCHEMISTS' CLUB. University, Glasgow, at 7.30 p.m. "Valency Linkages in the Light of Spectroscopy," by Dr. S. Sudgen.

INSTITUTE OF BREWING. *London Section.* Charing Cross Hotel, W.C. "Season's Malts," by A. Parry and Dr. J. H. Oliver.

TUESDAY, FEBRUARY 9.

INSTITUTE OF METALS. *Swansea Section.* Y.M.C.A., Swansea, at 6.15 p.m. "Zinc—the Utility Metal," by E. Evans.

INSTITUTE OF METALS. *North-East Coast Section.* Armstrong College, Newcastle, at 7.30 p.m. "Some Developments in Non-Ferrous Alloy Founding," by H. C. Dews.

INSTITUTION OF PETROLEUM TECHNOLOGISTS. *General Meeting.* Royal Society of Arts, John Street, Adelphi, at 5.30 p.m.

WEDNESDAY, FEBRUARY 10.

INSTITUTE OF FUEL. Cutlers' Hall, Sheffield, at 6.15 p.m. "Utilisation of Coke Oven Gas in the Iron and Steel Industry," by Dr. Ing. H. Lent.

SOCIETY OF GLASS TECHNOLOGY. *London Section.* Holophane, Ltd., Elverton Street, S.W.1. "History of the London Glass Bottle Trade," by R. Sharp. "Development of the Glass Instrument Trade," by H. J. Elliott and V. Stott.

INSTITUTE OF METALS. *London Section.* Northampton Polytechnic Institute, St. John's Street, E.C.1., at 8.15 p.m. "Some Recent Advances in Protective Coatings on Metals," by H. Sutton.

THURSDAY, FEBRUARY 11.

OPTICAL SOCIETY. Imperial College of Science and Technology, South Kensington, S.W.7., at 7.30 p.m.

INSTITUTE OF CHEMISTRY. *Manchester Section. College of Technology, Manchester,* at 7 p.m. "Recent Work on Alcoholic Fermentation," by Dr. A. Harden, F.R.S.

OIL AND COLOUR CHEMISTS' ASSOCIATION. *London Section.* 30, Russell Square, W.C.1, at 7.30 p.m. "Modern Ball-Mill Technique," by S. W. Kendall.

S.C.I. *Nottingham Section.* University College, Nottingham, at 7.30 p.m. "Safety in Chemical Industry," by J. Davidson Pratt.

FRIDAY, FEBRUARY 12.

ROYAL INSTITUTION. 21, Albemarle St., W.1., at 9 p.m. "Petroleum: A Record of Achievement in Applied Science," by Sir John Cadman.

COKE OVEN MANAGERS' ASSOCIATION. *Midland Section.* Grand Hotel, Sheffield, at 6.30 p.m. "Micro-Structure of Bituminous Coal," by Mrs. C. P. Finn.

CHEMICAL ENGINEERING GROUP. Burlington House, Piccadilly, W.1., at 8 p.m. "New Method of Measuring the Mechanical Properties of Metals," by L. H. Hounsfield.

S.C.I. *Glasgow Section.* Royal Technical College, Glasgow, at 7.30 p.m. Jointly with Glasgow Chemical Societies. "Significance of Valency as Elucidated by a Study of the Solid State," by Sir Wm. H. Bragg, F.R.S.

S.C.I. *South Wales Section.* Joint meeting with the local section of the Institute of Chemistry. Thomas' Cafe, Swansea, at 7.30 p.m. "Paint and Varnish Industry," by Dr. D. G. Hopkins.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by permission of the Controller of H.M. Stationery Office and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., price 1/- weekly (annual subscription, £2 10s.).

Latest Patent Applications.

812.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of amino-substituted organic arsênic compounds. January 11.

957.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of dihydroxy naphthalene dicarboxlic acid. January 12.

1,077.—Kamm, E. D.—Hydrogenation of phenols, etc. January 13.

Specifications Published.

365,019.—Soc. Elettrica ed Ellettrochimica Del Caffaro Carughi, A., and Paoloni, C.—Manufacture of chloridê of lime.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

Group Abridgments can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., either sheet by sheet as issued on payment of a subscription of 5s. per Group Volume or in bound volumes, price 2s. each.

354,948.—Phenols. Raschig Ges., Dr. F., Ludwigshafen-on-Rhine, Germany.

Chlorobenzene or a homologue thereof is catalytically converted to phenol or its homologues by treatment in the vapour phase with steam at a raised temperature in presence of aluminium oxide or hydroxide free from iron, or of a material which contains such aluminium oxide or hydroxide or yields such aluminium oxidê or hydroxide under the conditions of the hydrolysis. While the absence of iron from the catalyst is essential the presence of copper is advantageous since the reaction will then proceed at a lower temperature. A suitable catalyst is prepared by dissolving hydrated alumina in caustic soda lye and adding a hydrochloric acid solution of cupric chloride; the copper-aluminium hydroxide precipitate is filtered, washed and dried, and may be mixed with pure aluminium hydroxide. In examples (1) chlorbenzene and steam are conducted at 300° over a catalyst prepared as above: (2) *p*-chlortoluenê and steam is conducted over the same catalyst at 280°: (3) chlorbenzene and steam are passed at 480° over pure aluminium oxide; the reaction is carried out at 250° when the catalyst contains 2 per cent. of copper: (4) the vapours from a mixture of chlorbenzene and caustic soda lye are passed at 450° over pure aluminium oxide and the condensate returned to the boiling chamber where the phenol is fixed.

The Latest Trade Marks

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of His Majesty's Stationery Office.

GLINSTNTH.

518,754.—Chemical substances used in manufactures.—Skuse & Company, Limited, 7, Lamb's Conduit Street, London, W.C.1. January 20.

WYLAMON.

525,991.—All goods in Class 1 which includes chemical substances used in manufactures, photography, or philosophical research, and anticorrosives. — Consolidirtê Alkaliwerke, Douglashall No. 1, Westeregein, Bezerk Magdeburg, Germany. January 20.

RUNL.

528,042.—All goods in Class 2 which includes chemical substances used for horticultural, agricultural, veterinary and sanitary purposes. — Irish Chemicals, Limited, 17, Garfield Street, Belfast, Northern Ireland., January 20.

THE CHEMICAL NEWS

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EDITORIAL.

THE chaotic financial and economic conditions from which every country in the world is now suffering, makes ample excuse for our embarkation into the realms of Economics, as distinct from general science, the interests of which the *Chemical News* serves.

The Federation of British Industries, in its *Business Barometer* for the first quarter of 1932, issues a challenge to thinking people in a special number entitled "The Great Post-War Money Illusion." The gauntlet is thrown down to those who hold the view that the causes of the present crisis are merely monetary and the diagnosis of the trouble is given as over-production. In the long range forecast the probable chances and methods of recovery are reviewed at some length, both as regards this country and the rest of the world. The opinion given in this document is that there is no short cut to prosperity and that heavy losses will have to be borne and drastic re-organisations undertaken, but a rider is added to the effect that, provided Great Britain frames her National Policy wisely and is prepared to continue to make sacrifices and face the future adventurously, her recovery, though slow, should be continuous.

So much for the views of the F.B.I., a worthy National Institution in relation to the Federation of Great Enterprises, but an institution, judging by this document, which does not take into account the burden of a huge army of unemployed, an army which is fast becoming the breeding ground of discontent, a body of Britishers, which is largely composed of the men who were prepared to make greater sacrifices in 1914-18 than the one mentioned in the F.B.I. document, that only takes into account gold, and not the lives of honest Englishmen. Too long have we, as a nation, been making sacrifices to bolster up a creaking international credit system. Let us put away resolutions and suggestions which are only negative, and build on a constructive policy, which will bring employment and peace of mind to all of us. The cause of the crisis throughout the world is undoubtedly gold. With gold hoarded by one nation to the detriment of another, what happens? Why! Frozen credits, of course. So long as

the international creditors demand payment in a metal which has achieved a fictitious value, owing to its international scarcity, so long will the wheels of commerce remain clogged.

The F.B.I. have used a statement (with a section italicised by them and reproduced herewith), by that eminent economist, Sir Henry Strakosch, as evidence against gold being the menace.

" If there was a superabundance of all the goods we generally consume, *there was no reason why they would not all be exchanged one for the other*—unless, indeed, the power of consumption had reached saturation point. Ocular evidence of poverty and distress, however, was so abundant that the idea of consumption having reached saturation point became repugnant even to the meanest intellect." (The italics are F.B.I.)

The document then goes on :—

" If we were dealing with a *stationary* world, *i.e.*, a non-progressive world, this criticism of the over-production diagnosis might be valid. But to apply this theory to actual conditions of the business world and say that there is no reason why a superabundance of goods at any time should not ' all be exchanged one for the other ' at one time is to misconceive the whole *modus operandi* of trade. In the first place, while it is certainly true that the larger part of trade consists in the exchange of *current* goods, it is also true that a vitally important part relates to making preparations for *future* exchanges of goods. And in the problem under consideration it should be remembered that we are dealing with a part of trade exchange only. Even during the disastrous slump of last year it is probable that world trade in volume (not value) was not far short of 80 per cent. of what might be regarded as normal; that is to say, our difficulties are concerned with not more than about 20 per cent. of the exchange of goods; the fall in general prices being due to the fact that commerce abhors an excess of stagnant stocks."

But we must join issue with the author of this document at this stage. We are not dealing with a *static* world, in relation to trade. The demands of trade are ever-changing, sometimes in an upward trend in one commodity, and in another commodity the curve falls. This being so, the evidence is against, and not for, the suggestions put forward by the author of the booklet.

We are off the gold-standard—off it we must remain. The goods standard, governed if we like, by an index method, must supplant the gold-standard. We have arrived at a crisis in our history, greater than ever existed before, and we must all learn to think in terms of economics. The old ideas are as dead as the dodo—we must adjust our methods and views to modern conditions, governed, not by man-made devices, but by inexorable natural laws.

With an adequately controlled goods standard as a basis of exchange and currency, we avoid the use of palliatives, remonetisation of other so-called precious metals, and effect a stable control over credits. In our view, until such a system is adopted, the chaotic conditions now present will always be with us.

The F.B.I. must learn first principles. Science is dynamic and production is dynamic, so that the argument for the retention of a *static* metal to cramp the elasticity of wealth, has long been discredited by thinking people.

UNIVERSITY NEWS.

THE IMPERIAL COLLEGE, LONDON.

The Senate has decided to institute a University Chair of Inorganic Chemistry, to be held at the Imperial College. An appointment will be made to the Chair next September. A Board of Advisors has been constituted of Dr. Scott Lidgett (the Vice-Chancellor), Dr. Edwin Deller (the Principal), three external experts, namely, Professor G. T. Morgan, Professor R. Robinson, and Professor Sir James Walker, and four members nominated by the Imperial College, namely, Professor H. B. Baker, Mr. C. S. Garland, Sir Herbert Jackson, and Mr. H. T. Tizard (Rector).

Concurrently, three Chairs at the College are to be abolished : that of Optical Design, for the reason that the Department of Technical Optics is now to be a sub-department of Physics; that of the Technology of Woods and Fibres, which becomes unnecessary as a result of the establishment of the Forest Products Research Laboratory at Princes Risborough; and that of Chemical Engineering, in which subject the organisation is to be reveiwed when Professor Bone retires.

The Chemistry of the Conversion of Algæ into Bitumen and Petroleum and of the Fucosite-Petroleum Cycle

By J. E. HACKFORD, B.Sc., F.I.C.
Member of The Institution of Petroleum Technologists.

(*Continued from page 92.*)

Experimental.

Section II.

The Presence of Algæic Decomposition Products in Natural Oils and Seepages.

The following is a list of the samples examined. All were obtained from the Elk Hillsl, California, and labelled as indicated :

1. A sample (sec. 32, T30S., R.24E.) of clay, some of which is clean, some of which is stained dark brown, and on some of which is a laminated black substance in the fissures of the clay itself. The clean clay is of a battleship grey colour, slightly tinged with blue.
2. A sand (sec. 32, T30S., R.24E.) which is stained throughout by a brown or black coloration, containing laminæ of a spongy black material which can partially be separated from the sand by washing.
3. A clay (sec. 32. T30S., R.24E.), "Old Pit Clay," relatively more discoloured by the black material than sample No. 1.
4. A sample (sec. 14, T30, R.22), pebbles derived from a fault at the S.W. corner.
5. *A sand* (sec. *11, T32S.*, R.24E.), "Beuna Vista Blowout," impregnated with oil and containing free acid. It is brown and contains numerous white specks.
6. A solid bitumen or a heavily organic bituminous shale (Sect. 18, T30, R22), "McKittrick Dyke." This bitumen is of a decided brown colour similar to freshly precipitated ferric hydroxide. It is brittle and fissured; along the lines of fissure there is a light grey colouration. The inorganic matter is a diatomaceous earth.
7. A Black Sand from Lamont Cut (sec. 32, T30S., R.24E.).
8. A Clean Sand from Lamont Cut (sec. 32, T30S., R.24E.).
9. Clean Sand Cut No. 1. This cut being on the same side of the gulch and north of Lamont Cut.
10. Clean Sand Cut No. 2 on the opposite side of the gulch from the Lamont Cut and below cut No. 3.
11. Clean Sand Cut No. 3. On the same side of the gulch and higher up the hill than cut No. 2.
12. 3 samples of oil and sludge from the tanks of Well No. 7, situated in the S.E. ¼ of the S.E. ¼ of the N.W. ¼ Sect. 1, T31S., R.24E.
13. 2 samples of oil and sludge from the tanks of Carmen Oil Well No. 5. sec. 36, T30S., R.24E.
14. 2 samples gas, one from Well No. 7 (sample 12) and one from Well No. 74, sect. 31, T30S., R.24E.

The Presence of the Calcium Salts of the Ethereal Sulphonic Esters.—The presence of this type of salt is illustrated by samples Nos. 5 and 13.

Seepage No. 5 is a dark sand containing a number of white specks, which proved on examination to be calcium sulphate. Quantities of gas were evolved from the sand which contained 12 per cent. of oil, of a character similar to that obtained from wells samples Nos. 12 and 13. The sand also contained relatively large quantities of free sulphuric acid, which destroyed the paper and linen containers in which the samples were packed. On washing the sand with water, a brown solution containing 1.82 per cent. of organic matter was obtained, calculated on the sample, which upon evaporation formed a jelly. The sand also contained small quantities of a substance which swelled up in water, and also a bituminous material of the nature of an oxykerite, and which is described later.

The Aqueous Extract.—A quantity of aqueous extract was made by enclosing the sand in a linen bag and placing the same in an autoclave containing water. The water was boiled until the steam pressure registered 25lb./sq. in., and after being maintained at that pressure for one hour the autoclave was allowed to cool, and the water collected. This acid aqueous extract was concentrated, and, on the addition of excess of alcohol, a light brown flocculent precipitate was thrown down. This precipitate

was filtered off, redissolved in water, and reprecipitated twice by alcohol. The precipitate was then white in colour, and the aqueous solution gave a neutral reaction.

Upon hydrolysis in a 5 per cent. by weight sulphuric acid solution, it was noticed that a skin formed on the surface of the liquid in the same way as it forms on the surface of the aqueous seaweed extract. Hydrolysis was continued for four days, during which time a precipitate resembling algarite was thrown down, separated and filtered off. The filtrate contained sugars, reduced Fehling solution, and yielded an osazone of a mixed nature; it gave a precipitate with tungstic acid, thereby indicating the formation of tertiary amines, and also yielded a precipitate when neutralised with ammonia. The ammonia precipitate yielded appreciable quantities of oil on drying in the water oven.

A light-coloured oil was extracted from the hydrolysed liquors by means of chloroform in comparatively large quantity. As all these reactions point to the substance being the calcium salt of the ethereal sulphonic esters, the ash content (11 per cent.) was examined and found to consist wholly of calcium sulphate.

Sample No. 13.—When the fuel oil residue (boiling over 300° C.) of this sample of oil was heated with water in an autoclave to 25lb. steam pressure for 24 hours, partial solution of the oil took place. The aqueous solution was alkaline, and when neutralised threw down a thick flocculent, buff-coloured precipitate soluble in boiling water, and reprecipitated by alcohol. 1000 ml. of fuel oil were extracted and 11 gm. of this water-soluble material was obtained. This precipitate contained 22.8 per cent. of ash which contained calcium, iron magnesium, etc. The calcium present was in the form of the sulphate. The precipitate was washed with chloroform to remove traces of adherent oil, and was then hydrolysed with a 5 per cent. sulphuric acid solution as before. The resultant solution contained tertiary amines, sugars and yielded oil upon chloroform extraction as in the case of sample No. 5.

The Presence of Free Sulphuric Acid.—The presence of free sulphuric acid is best exemplified in the case of sample No. 5. An aqueous extract of this sand is strongly acid to litmus, and gives a heavy precipitate with barium chloride in the presence of nitric acid.

The Presence of Calcium Sulphate.—Calcium sulphate is distributed throughout sample No. 5 as white specks. Strong hydrochloric acid dissolved the major part out, and both the calcium and the sulphate radicle were identified in the solution.

The Presence of Sugars.—The presence of sugars in a combined form was found in all except the gaseous samples. Sugar was found in the free state in one instance.

Sample No. 13.—The water that accompanied the oil drawn from the well separated out in the settling tank, and when tested was found to reduce Fehling's solution, and to give osozones with phenyl hydrazine acetate. This is the only instance where sugars were found directly as such. 27 ml. of water were present in the 1-gall. oil can in which the sample was dispatched, and was too little to permit quantitative determinations to be made.

Samples Nos. 1, 2, 3, 7, 8, 9, 10, 11. *Definition.*—The brown or black material found in the above sands and clays will be proved to be a partly hydrolysed fucose-pentosan, intimately mixed with its own decomposition products, of which oil, naphthenic acids, and an oxykerite may be mentioned. This oxykerite is the predominating decomposition product, and is formed, as shown later, by the prolonged oxidation of the oil at low temperatures. The bulk of the material is, however, the partly decomposed pentosan fucose, and hence, for the sake of convenience, the black material will be called "fucosite."

The oxykerite, mentioned above, is common to all the other seepages, and as it has its own peculiar properties it is proposed to call this material "elkerite." The termination "'ite" is used in both cases to indicate the relationship of these substances with naturally-occurring kerites.

The fucosite found in the sands ran vertically through the beds. It was laminated and, in some cases, could be peeled off in sheets of up to ¼in. in thickness, to which a quantity of sand still adhered. On being placed in a beaker and covered with water, it swelled up to six or seven times its natural size, and had the appearance of a brown, gelatinous, laminated mass. It was tough like soft indiarubber. The inside of the mass was comparatively free from sand. All the fucosite was not in a laminated con-

dition. The mode of its disposition suggested a fluid carrying a solid in suspension, which had forced its way through a series of fissures, thus giving the laminations, and to some extent, into the surrounding porous sand and deposited its solid matter in the interstices, a condition which would obtain if the sand had acted as a filter.

The so-called "clean" sands also had minute quantities of fucosite distributed throughout the beds. It had a tendency to collect in those places where the sand contained small quantities of clay, which held up and adsorbed the material and its decomposition products during their passage through it. The distribution of fucosite in the clay samples was similar to that existing in the sands. There were black veins of the material, and a brown colouration permeating the clay for distances between ¼in. and 2in. around the fissure.

The Separation of Fucosite.—The separation of fucosite from the accompanying sands was carried out in the following manner.

The sand was soaked in water for one week, when the fucosite swelled up and pieces varying in size, up to 1 × 1 × ¼in., could be picked out by hand. The whole was filtered through a 40-mesh gauze, which passed most of the sand and retained the fucosite, still mixed with some of the larger particles of sand. The mixture was placed in a glass tube 1 metre long and 4 cm. diam., at the bottom of which was a water inlet connected to the high-pressure water tap. By adjusting the velocity of the water running through the tube a very good separation could be effected.

In the case of the clays, two or three grams of fucosite were collected by breaking the clay at the fracture, and levering up the laminæ with a penknife.

In the case of the "clean" sands the procedure followed was to look for stained portions, if any, and to subject them to the water elutriation described. Some of the sands, however, appeared to be entirely clean; and in this case the whole was stained by an alcoholic solution of erythrosine, and allowed to stand in a warm place for a day. The sand was then transferred to a 200-mesh gauze and washed with cold water until clean and free of dye. Numerous samples were then taken and examined under the microscope, by means of which the fucosite—now stained pink—could be readily identified. The fact that fucosite is opaque to polarised light was also very helpful in its identification.

Microscopical Examination. — Prof. Tabor, of the Imperial College of Science and Technology, reports that "On microscopic examination this material proves to be wholly composed of a unicellular blue-green alga, belonging to the family of cyanophycæa, and is therefore entirely of vegetable origin." Mr. Tandy, of the British Museum (Natural History), partially supports this view after an examination of microtome sections cut at 10μ, and reports that the material does not wholly consist of cyanophycæa. Dr. Wade also examined the specimens and reported that the material consisted wholly of blue-green algæ.

Interspersed throughout the mass there were pieces of elkerite.

Properties.—The physical properties of fucosite have already been described.

Fucosite contains approximately 0.5 per cent. of oil soluble in carbon disulphide.

Upon dry distillation fucosite yields an oil very much resembling that obtained from peat. The yield was approximately 25 per cent. of the dry weight of the fucosite. There was not enough of the original material to obtain enough oil upon which to carry out the usual physical determinations, but there was just enough to be dried and to give an ultimate analysis: C, 78.1 per cent.; H, 10.2 per cent.; O, 8.08 per cent.; N, 1.72 per cent.; S, 1.90 per cent.

The gas evolved during the dry distillation had the following composition, the analysis being carried out in a Bone-Wheeler gas analysis apparatus. CO_2, 55.2 per cent.; H, 14.06 per cent.; C_nN_{2n+2}, 15.0 per cent.; C_nH_{2n}, 3.2 per cent.; CO, 8.1 per cent.; N, 4.5 per cent.; H_2S, nil.

When fucosite is burnt the odour evolved is that of burnt feathers. The material is readily soluble in dilute alkalis from the solution of which it is precipitated by acids. It is very sparingly soluble in water, dilute acids, and organic solvents.

In one experiment 10 gms. of fucosite obtained from sample No. 2 were placed in an Erlenmeyer flask and hydrolised with 100 ml. of a 3 per cent. solution of hydrochloric acid for four hours, under a reflux condenser. The hydrochloric acid solution rapidly

turned a lemon-yellow colour, and ultimately a port wine red. The contents of the flask were then filtered and evaporated down on the water bath, the liquors smelling strongly of burnt sugar. Some needles separated out after cooling overnight and were hand-picked next morning. These were carefully recrystallised from about 10 ml. of water and dried in the desiccator. The melting point was 157° C.; arabinose requires 159-160° C.

The remaining solution was then diluted and decolorised with animal charcoal, and filtered. The filtrate rapidly reduced Fehling solution, and yielded an osazone with phenyl hydrazine acetate. This osazone was of an orange colour, but after recrystallisation from hot water the colour was a lemon yellow. The crystals were dried overnight in the desiccator, over sulphuric acid. M.P. = 157-158° C.; arabinose requires M.P. 158-150°C.

Another osazone was also obtained, melting at 127-134° C. Fucosazone melts at 130-140°C.

The decolorised liquor was also tested in the polariscope, and found to be slightly lævorotatory. The quantity of material in the decolorised liquor was unknown, the volume was 10 ml., and the rotation was —1.7°.

A similar hydrolysis was made with hydrochloric acid having a specific gravity of 1.06, refluxing taking place for a period of four hours. After filtration the liquor was distilled and the distillate gave the furfural reaction by turning an aniline acetate paper pink.

The formation of oil from fucosite was proved: 10 gms. were hydrolysed with a 5 per cent. solution of sulphuric acid for one week. From the filtered liquor 1.28 gms. of an oil similar to that described as having been obtained from seaweed was obtained by extraction with chloroform.

As before mentioned, fucosite contains traces of free oil which can be obtained by extraction by carbon disulphide in a Soxhlet apparatus. The yield varies from 0.8 to 0.5 per cent. on the dried weight of the material.

Traces of free naphthenic acids are also present in fucosite. These can be isolated by extracting the solution obtained upon acidifying a freshly-made alkaline solution of the material with chloroform. The isolated acids are dark brown in colour, soluble in soda, etc., and possess the characteristic odour.

Upon hydrolysing fucosite for two days in acid solution the formation of the calcium salts of the ethereal sulphonic esters was shown by the formation of a precipitate thrown down by ethyl alcohol. Tertiary amines and ammonium salts were also formed, as well as the sugars described above.

By alkaline hydrolysis with a 2 per cent. sodium carbonate solution the above bodies were also formed, with the exception of oil, which as previously remarked does not appear during alkaline hydrolysis. Remembering the formation of naphthenic acids during acid hydrolysis of algæ, it is, of course, possible that the sodium salts of these acids are formed.

Sample No. 6.—The solid bitumen from the McKittrick Seep is a brown, friable material, on the fissures of which is a greyish-yellow coating of elkerite. As this bitumen proves to be an oxykerite, it is proposed to call it "McKittrite," as it possesses several distinctive properties.

On heating, McKittrite swells, and sinters at about 200° C., giving off a faint odour of burnt feathers. Upon ignition, it yields an ash—16 per cent.—consisting of sand, clay, and calcium sulphate. The percentage of ash in the kerite itself, is small—0.81 per cent.—and this contains comparatively large quantities of vanadium and the rarer elements.

The organic matter, of which this kerite is composed, is made up of :—

	%
Fucosite (insol. in org. solvs.) (Kerenes)	18.28
Keroles — similar to algarite (sol. only in pyridine)	2.72
Kerols (sol. in pyridine and chloroform)	48.6
Asphaltenes (sol. in pyridine, chloroform, carbon disulphide)	35.4

The fucoside was obtained, along with the inorganic matter, after extraction firstly with chloroform and then with pyridine. The insoluble mixture was then boiled with hydrochloric acid to remove soluble inorganic matter, and the organic matter left contained only heavy particles of sand which were separated by decantation with water. The bulk of the organic matter consisted of fucosite, and could be readily identified under the microscope by the spotted, bubbly

appearance of its yellow laminæ. It contained, also, quantities of elkerite, which were identified by the plain, transparent yellow plates of irregular shape. The fucosite so obtained was readily soluble in soda solution.

The Keroles and Kerols were black amorphous powders, soluble in their respective identifying organic solvents, as also in aqueous sodium hydroxide solution. The keroles swell and sinter at 220° C., while the kerols swell and sinter at 180° C. On further heating they evolve water, oil, traces of ammonia, and sulphuretted hydrogen.

The asphaltenes are of a deep red colour, and have the appearance of a semi-solid asphaltic bitumen, with the exception that they are much more transparent to light than is usually the case. They are soluble in carbon disulphide, insoluble in petroleum ether, but readily soluble in ethyl ether.

The organic matter of McKittrite, *viz.*, the portion soluble in chloroform, contains :

Nitrogen	1.02 per cent.
Sulphur	2.50 ,, ,,

Sample No. 4.—These pebbles were embedded in a black covering of elkerite. On scraping, the coating came off in flakes which appeared as transparent, irregular, yellow plates under the microscope. These plates were perfectly plain and showed no bubbly nor cellular appearance. They resembled thin plates of yellow glass, but were opaque to polarised light. Elkerite is soluble to a small extent in both acids and water, and slightly swells in the latter solvent. It is sparingly soluble in a solution of sodium hydroxide. Upon hydrolysis with hydrochloric acid the resultant liquors reduce Fehling solution and yield osazones, behaving like fucosite and algarite in this respect.

On heating, elkerite sinters and evolves water, oil, and gases, the latter possessing the smell of burnt feathers.

The Presence of Furfurol.—Furfurol has already been described as being one of the decomposition products of fucosite.

The Presence of Tertiary Amines and of Ammonium Salts.—These bodies appear during the hydrolysis of fucosite, elkerite and McKittrite. The methods employed for their detection are similar to those employed and described in the experiments demonstrating their appearance during the acid hydrolysis of the seaweed extract.

(*To be concluded.*)

THE CHEMICAL INDUSTRY IN GERMANY, 1931.

The Booklet just issued by the Board of Trade (Overseas Department) entitled "Economic Conditions in Germany," throws into interesting relief the relation of Germany's Chemical and Allied Industries to that country's main trade. Like all other branches of industry, the German Chemical Industry last year suffered its first setback for six years owing to the continued depression among its principal consumers, the textile, building and agricultural branches of Trade and Commerce. It is only natural that, with depression rife among every consumer of chemicals, such depression must be severely felt in a basic industry. There was, however, an improvement in the first six months of 1931 and the position was regarded with optimism.

German chemical exports declined in value by about 17 per cent. in comparison with the figures for 1929, but the decrease was largely due to the international agreement regarding nitrogen fertilisers, the foreign trade in which declined by some Rm.100 million. Otherwise, sales were on the whole well maintained. The lower figures for dyestuffs were not as pronounced as the falling off in the textile trade.

The following table shows the principal exports :—

Exports of German Chemical Industry.

	1926	1928	1930
	(Rm.	million)	
Heavy chemicals ...	234.7	259.8	251.0
Charcoal product ...	13.8	16.8	14.9
Nitrogen fertilisers ...	205.5	280.0	188.9
Phosphorus fertilisers	10.6	12.7	9.9
Coal tar dyes	216.5	286.7	196.4
Mineral dyestuffs ...	84.9	95.4	99.8
Paints and Varnishes	10.3	20.7	21.8
Explosives and munitions	25.6	27.8	24.2
Pharmaceuticals ...	93.9	119.9	122.5
Essential oils and perfumes	16.7	20.0	18.6
Cosmetics	11.2	14.8	18.1
Glue and gelatine ...	18.6	14.9	20.4
Tanning extracts ...	3.7	4.6	5.5
Rayon	32.8	69.2	64.8
Moulding materials...	19.3	30.8	26.2
Photographic materials	31.9	46.2	48.2
Other chemical products	36.8	48.8	54.0
Total	1,061.8	1,318.6	1,160.4

GERMAN DYE TRUST
(I. G. FARBENINDUSTRIE).

The annual report for 1930 stated that turnover and profits earned had been affected by the general economic crisis. Exports of dyestuffs from all countries declined by about 10 per cent., but the German proportion of total sales was somewhat hgher. An improvement in market conditions in the Far East was attributed to working agreements with the French and Swiss chemical industries. For inorganic chemicals, solvents and light metals, improved manufacturing methods and new uses largely compensated for the lower demand and in some cases sales increased. The position as regards pharmaceuticals and insecticides was very satisfactory and considerable progress took place in sales to various foreign countries. The output of perfumes was maintained at the level of 1929, while business in photographic materials, which developed up to expectations in Germany, was extended in overseas markets. The quantity of rayon sold remained at the preceding year's figures. The unfavourable trend of the nitrogen market is dealt with in the following section. The staff of the firm at the end of 1930 numbered 79,963; including associated mines and works the corresponding figure fell from 181,752 in 1929 to 114,197 in 1930.

From October, 1930 onwards, sales of chemicals and dyestuffs were concentrated at Frankfort, the sales offices for pharmaceuticals and insecticides remained at Leverkusen and for photographic materials, rayon, perfumes and fertilisers in Berlin. The output of associated firms decreased as follows in 1930 against 1929 :—Coal from 1,148,982 tons to 1,068,994 tons, coke from 508,709 tons to 450,981 tons, lignite from 20,289,467 tons to 15,996,486 tons. Depreciation accounted for Rm.57 million, as against Rm.70 million in 1929, the net profit was reduced from Rm.110 million to Rm.89 million, out of which a dividend of 12 per cent. was again declared on ordinary share capital; the latter amounts to Rm.714 million; shares with a value of Rm.87 million were withdrawn during the year.

The I.G. Chemie, Basel, the Swiss holding company for the foreign interests of the German Dye Trust, was able to pay a dividend of 12 per cent. without resorting to the guarantee given by the Trust.

The American I.G. Chemical Corporation, New York, had a net profit of 2,328,000 dollars, which was placed to reserve.

The following is a list of important associated firms within Germany :—

Participations of German Dye Trust.

Firm	Share holding of Dye Trust Rm. 1,000	Out of total ordinary capital Rm. 1,000	Chief products
Ammoniakwerk Merseburg Gm.b.H., Merseburg	101,250	135,000	Nitrogen and petrol
Rheinische Stahlwerke, Essen-Ruhr	67,078	150,000	Coal, coke and by-products
Leopold Cassella and Co. G.m.b.H., Frankfort	40,480	60,880	Dyestuffs (works rented)
A. Riebeck'sche Montanwerke A.G., Halle a.S.	28,453	50,000	Briquettes, tar, lignite, oil, paraffin, etc.
Gewerkschaft Auguste Victoria, Hüls	16,881	18,550	Coal, coke and by-products
A. G. fuer Stickstoffdünger, Knapsack	7,928	8,000	Carbide, acetic acid, natrium, lime nitrogen

Halle & Co., A.G. Wiesbaden-Biebrich	5,959	8,000	Cellophan, ozalid
Duisburger Kupferhütte, Duisburg	5,431	6,000	Copper, zinc oxide, pig-iron, sulphate of soda
Gewerkschaft Elise II, Halle a.S.	5,000	5,000	Lignite
Dr. Alexander Wacker, Ges. f. elektrochemische Industrie G.m.b.H., Munich	3,750	7,500	Caustic soda, carbide, etc.
Chemische Werke "Lothringen" G.m.b.H., Gerthe (Westphalia) ...	3,000	6,000	Nitrogen products
Deutsche Celluloid-Fabrik, Eilenburg ...	2,716	5,000	Nitro-cellulose celluloid
Zuckerfabrik Körbisdorf A.G., Körbisdorf	2,476	2,700	Lignite
Grube Auguste, Bitterfield	2,280	2,400	,,
Deutsche Grube bei Bitterfield, A.G., Bitterfield	2,275	2,500	,,
Ford Motor Company, A.G., Berlin ...	2,250	15,000	Motor cars, tractors, etc.
Consolidirtes Braunkohlen - Bergwerk "Caroline" bei Offleben, A.G., Madgeburg	2,216	2,408	Lignite
Aceta G.m.b.H., Berlin-Lichtenberg ...	2,000	2,000	Rayon
Behringwerke A.G., Marburg a.d. Lahn	1,786	1,800	Sera
Hoëlkenseide G.m.b.H., Barmen	1,500	3,000	Rayon
Wachtberg-Gruppe, Braunkohlenwerke, Frechen nr. Cologne	1,004	1,070	Lignite-briquettes

Explosives.

With regard to the projected merger of six other firms in the explosives branch with the Dynamit A.G., vorm. Alfred Nobel and Co., of Hamburg, this company, the Rheinisch-Westfälische Sprengstoff A.G. and the A.G. Siegener Dynamitfabrik, of Cologne, reported a reduced turnover owing to lower requirements of the coal mining and stone quarrying industries at home and abroad. The dividends of 6 per cent. for Nobel and 4.8 per cent. for other companies were guaranteed by the German Dye Trust. The merger was approved at general meetings held in June, 1931. The works of the remaining four companies, Deutsche Sprengstoff A.G., Rheinische Dynamitfabrik, Dresdner Dynamitfabrik and Westdeutsche Sprengstoffwerke A.G., all of Cologne, are not in commission.

Nitrogen.

International Convention.—In August, 1930, an international nitrogen convention was formed, comprising, together with the output of lime nitrogen, over 98 per cent. of the European nitrogen production and, with the Chile saltpetre industry, about 80 per cent. of the total capacity in all countries. It was estimated that output in the years 1928-29 and 1929-30 amounted to 2.1 and 2.2 million tons respectively, while consumption in the corresponding periods was only 1.9 and 2.0 million tons. Stocks in June, 1930, were given as 860,000 tons. Production of the convention members was fixed at 1.1 million tons, of which 840,000 tons were allotted to Germany, Great Britain and Norway together. The agreement was arrived at provisionally for one year and efforts to obtain an extension for ten years were unsuccessful in July, 1931. The German Ministry for Economic Affairs made provision, by the introduction of heavy duties, against the flooding of the home market with foreign nitrogen products.

Foreign Trade.—Apart from the effect of the regulation of the market by international agreement, agricultural depression had a serious influence on nitrogen sales.

Exports in the past few years were as follows :—

German Exports of Nitrogen Fertilisers.
(Metric tons.)

	1927	1928	1929	1930
Nitrate of soda	60,276	32,421	69,411	65,196
Nitrate of potash	21,243	23,161	28,534	26,000
Sulphate of ammonia	669,880	887,257	726,813	463,682
Lime nitrogen	563	368	1,264	6,353
Nitrate of lime, urea	268,504	395,586	494,336	308,982
Estimated total content of pure nitrogen	192,000	242,000	244,000	160,000

The heavy decrease in 1930 is partly accounted for by the reduction in reparation deliveries to France.

Imports of sulphate ammonia, which in 1928 and 1929 were only about 200 tons per annum, rose in 1930 to 44,760 tons, half of which was from Poland.

The home demand for nitrogen fertilisers in the first six months of 1931 was higher than a year ago and sales abroad were described as satisfactory.

The Nitrogen Syndicate issued a new price list for the export trade in July, 1931, in which quotations for nitrate of lime were reduced by 10 per cent. and for sulphate of ammonia by 35 per cent.

POTASH INDUSTRY.

The German potash industry was relatively well situated during the crisis of 1930.

Sales.—Sales were maintained at the previous year's level up to the end of October. The official price reduction campaign was largely responsible for the backward attitude of consumers in November, when turnover suffered a heavy decline, while in December demand again improved considerably. Sales for the year amounted to 1.36 million tons of potash salts (K_2O), compared with 1.40 million tons in 1929. The total value of the turnover, including by-products and sundry revenue, was estimated at Rm.250 million.

Sales in the respective months were as follows :—

	1930	1929
	Metric	tons
January	186,015	164,773
February	202,723	144,695
March	187,611	232,828
April	79,757	112,549
May	77,187	77,293
June	95,947	97,768
July	98,859	89,201
August	98,745	95,420
September	127,644	123,481
October	71,675	79,152
November	54,872	84,664
December	80,699	99,583
	1,356,724	1,401,406

The reduction in sales, amounting to 44,700 tons, was largely due to lower consumption in Germany, where the depressed position of agriculture received the attention of the Government as well as of the Potash Syndicate. The new sales conditions from the 1st December, 1930, granted considerable advantages to consumers, particularly in regard to freight charges over long distances, and for orders placed before 22nd December, 1930, special rebates or discounts were allowed. A comparison of old and new prices is given below :—

Price per 10 tons ex works. (Reichsmarks.)	Present freight	Total price up to present	Future freight	Total price in future	Change in price
Near Works—					
12% Kainit 130	—	130	19	149	+15
40% Potash salts 755	—	755	19	774	+2.5
200 km. distance—					
12% Kainit 130	48	178	43	173	-2.8
40% Potash salts 755	48	803	43	798	-0.6
East Prussia—					
12% Kainit 130	94	224	59	189	-16
40% Potash salts 755	94	849	59	814	- 5

Sales from January to June, 1931, amounted to 624,267 tons of potash salts, compared with 829,230 tons in the corresponding period of 1930.

Exports of potash fertilisers in 1930 amounted to 991,684 tons valued at Rm.60.06 million, which figures are 8 per cent. in quantity and 10 per cent. in value less than in 1929; the decrease was almost entirely due to reduced exports to Poland. The following table gives the exports of potash fertilisers from Germany in 1929 and 1930:—

Exports of Potash Fertilisers from Germany in 1929 and 1930.

Destinations	1929 Tons	1930 Tons
Belgium	64,220	64,603
Denmark	52,910	59,414
Estonia	2,745	4,228
Finland	16,484	17,962
Great Britain	67,085	59,988
Italy	12,350	16,771
Latvia	7,130	8,050
Netherlands	204,936	231,786
Norway	18,576	21,582
Austria	13,933	14,201
Poland (without Polish Upper Silesia	98,867	20,955
Polish Upper Silesia	7,842	1,296
Russia	5,098	—
Sweden	71,102	67,353
Switzerland	6,267	9,669
Czechoslovakia	108,460	78,261
Hungary	8,569	1,966
United States	282,157	278,683
New Zealand	2,457	4,394
Miscellaneous	30,961	30,522
Total	1,077,149	991,684

By-Products.—With regard to the activities of the "Interessen-Gemeinschaft der Deutschen Kali-Industrie G.m.b.H.," the company which was formed in January, 1930, to control the sales of four associations for potash by-products, viz., rock salt, Epsom salts, bromine and chloride of magnesium, the association agreements are provisionally valid until the end of 1934 and are subsequently extended automatically for periods of five years unless six months' notice of termination has been given. Sales of rock salt in 1930 amounted to 1.95 million tons, as against 1.92 million tons in 1929, but the average price was said to be lower. The turnover in bromine was probably greater than in 1929, while trade in Epsom salts and chloride of magnesium was about the same.

International Agreements.—In order to put an end to keen competition in east Germany an agreement was arrived at in February, 1931, between the German Rock Salt Syndicate and the Polish rock salt industry, by which the former agreed to take over 6,000 tons of Polish rock salt per annum carriage paid to the frontier and to dispose of it at fixed prices.

Another agreement was concluded between the Schwarzburger Saline Oberilm A.G., Stadtilm, Thuringia, with Dutch producers concerning a division of rock salt markets and the maintenance of prices. Negotiations for a similar arrangement with French competitors were also conducted by the above company.

Production. — During the past year, potash production was again carried on by about 40 mines and 80 works, which, it was estimated, were employed at 70 per cent. of their capacity. There was little change in the output quotas of Potash Syndicate members, apart from an allocation of the participation held by two mines of Preussag, which were closed owing to being flooded, and a slight increase granted to a Burbach works. A re-assessment of members' quotas, which should have taken place by the 1 January, 1934, according to syndicate statutes, was postponed until 31 December, 1943, by a decree of the German Minister for Economic Affairs.

Amalgamation.—The Wintershall concern took over the Sauer Works, in which they had previously acquired a strong participation. The transaction enabled certain concentration of output and the temporary closing down of one mine. Kali-Chemie A.G., which now owns three potash works and seventeen chemical factories, obtained possession of the Heyl-Beringer Farbenfabriken A.G. Part of the large carbonate of potash works of this firm at Stassfurt will be ready to commence production about the middle of this year.

Financial.—The dividend policy of the principal groups has not been uniformly influenced by market developments. The Burbach concern has again declared a dividend of 12 per cent., the Wintershall Works have decided to reduce their dividend from 12 per cent. in 1928 to 8 per for 1930. The Salzdetfurth group also decided to pay a

dividend of 15 per cent. on Salzdetfurth shares and 10 per cent. each on the shares of Aschersleben and Westeregeln as in 1929.

OIL BORING INDUSTRY.

An unprecedented impetus was given to oil boring in Germany in 1930, partly as a result of the activities of foreign concerns.

The North European Oil Corporation found the Nord-Europäische Oegesellschaft m.b.H., Berlin, with a capital of Rm.1 million as a holding company for the following firms :—

Oldenburgische Erdoel G.m.b.H., Oldenburg, with the subsidiaries Oldenburgische Oelausbeutungs G.m.b.H. and Allgemeine Erdoel G.m.b.H., of Oldenburg.

Ostöl, G.m.b.H., Berlin.

Westöl G.m.b.H., Berlin.

Erdölwerke Wathlingen G.m.b.H.

Mecklemburgische Erdoel G.m.b.H.

Gewerkschaft Regina, Caan, Brunswick.

Gewerkschaft Mathias, Siegen.

Harburger Bergbau-Gessellschaft m.b.H.

Oil boring concession were acquired in Hanover, Bremen and Oldenburg covering some 1½ million acres. In May, 1931, part of these concessions was sold to the Royal Dutch Shell for 900,000 dollars, who were to concentrate their interests chiefly in the east of Rhineland and Westphalia. As far as is known the wells sunk by the North European Oil Corporation have not yet met with any success.

The development of the crude oil output in Germany was as follows :—

German Output of Crude Mineral Oil.
(Metric tons.)

Year	Total output	Including: Wietze	Nienhagen	Oberg-Oelheim
1921	38,389	34,221	3,116	965
1922	41,995	31,266	9,751	901
1923	50,770	34,058	15,208	1,452
1924	59,352	38,045	20,280	1,024
1925	79,180	39,527	37,289	1,053
1926	95,367	44,218	47,776	3,347
1927	96,883	46,866	45,150	4,867
1928	92,003	46,106	39,198	6,714
1929	103,798	48,226	44,413	11,159
1930	169,552	61,077	83,772	24,743

A considerable increase in production is expected in the current year. Output in the Wietze-Steinförde district was at the begining of 1931 largely controlled by the Deutsche Petroleum A.G., in the Hänigsen-Nienhagen area by Gewerkschaft Elwerath and around Oberg-Oelheim by the Norddeutsche Erdoel A.G. The shares of the last-named company were acquired in March, 1931, by the Magdalena Syndicate Corporation, of New York, which was to expend Rm.2 million on new borings and a similar sum for the development of the oil refinery. In September, 1930, Gewerkschaft Elwerath was successful in boring the most productive well as yet struck in Germany, the output being given as 400 tons per day. The Preussiche Bergwerks-und Hütton A.G. (Preussag) took over in November, 1930, extensive boring rights from Anton Raky A.G. with four wells in commission and two under construction in order to prevent their acquisition by American concerns. The "Preussag" has since extended its oil interests.

The chief potash concerns have also displayed activity with regard to oil boring. The firm of Burbach discovered a well with a capacity of 60 tons of high grade oil per day in their potash mine at Volkenroda, Thuringia. The Wintershall company bought up a strong share holding in Gewerschaft Elwerath, who are building a refinery at Miesburg, near Hanover, in conjunction with "Preussag." The provisional capacity of the new refining plant is stated to be from 70,000 to 80,000 tons per annum, which is the estimated production of Elwerath and "Preussag" together, although provision has been made to deal with an output up to ten times this quantity if required. In addition, the Westeregel concern secured an option on certain oil boring rights.

CHEERFUL MESSAGE FROM PRESIDENT OF THE AMERICAN CHEMICAL SOCIETY.

The future of chemistry and chemists in America never looked brighter, Dr. L. V. Redman (who on January 1, assumed office as president of the American Chemical Society), declares in a new Year's Message to the Society's 19,000 members in all parts of the world.

"A new year is upon us," says Dr. Redman, who is vice president and director of research of the Bakelite Corporation, Bloomfield, N. J. "What of chemistry and chemists in America? To the promotion of their welfare our Society stands committed. Have we builded well for future achievement?

"What seem to be the facts? We have greater wealth than ever before; wealth to endow education and research in the pure science; wealth to finance industrial research and its exploitation.

"Men of finance, industry, and commerce are becoming more and more research-conscious. We have a broadening foundation of knowledge on which to build an expanding, inexhaustible territory to be explored and cultivated. We have a greater number of well-trained workers.

"True, we have much to learn about the control of wealth, whether of labour or of commodities. We have not learned to achieve economic stability. But in terms of living, every crest of the wave has been higher and every trough less depressed. We are reassured by the fact that our present condition is one of maladjustment, not poverty; surfeit, not famine.

"The man of business may be getting a dangerously exalted estimate of the possibilities of research. He will come to learn its limitations. His interest will grow; the results will compel it.

"In the early days of science there were those who believed its domain to be narrowly bounded. Few to-day do not see its horizons receding with every advance.

"Years ago we were told that there would soon be an oversupply of men trained in chemistry. Some fear that such fate is now upon us. But before these days of doubt and uncertainty, the schools were not keeping up with the demand for men of good training.

"To-day, discouraging as is the immediate outlook for many, the proportion of those who are idle is, to say the least, no higher among chemists than among those in other walks of life. We shall again have a scarcity of well-trained men.

"Science properly taught is as cultural as the humanities. A foundation of training in chemistry and the allied sciences is of value in all walks of life. It is neither necessary nor desirable that all men trained in science, practice a scientific calling.

"The need is for leaders in finance, industry, and commerce who understand the possibilities, and the limitations, of modern science.

"What with our increasing wealth, the growing appreciation of the value of research, our ever expanding knowledge, the increasing number of men of power and initiative who are devoting their lives to chemistry or its practical application, the future of chemistry and chemists in America never looked brighter."

THE AGE OF LIGHT.

All the world to-day, slowly emerging from a testing-time of gloom, sees in a combination of light and colour a new stimulus to life and pursues them most vigorously in its leisure hours. Their welcome influence on our home surroundings is already beginning to be felt, and in the near future will be more profound.

The most advanced developments of colour and light revealing, in studied combination with glass and chromium-plate, effects which are of only recent invention, are promised as the theme of the sixteenth Daily Mail Ideal Home Exhibition, which opens at Olympia, Kensington, W., on April 5.

Radiant City of Light.

A City of Light, conceived and planned with an ingenuity and artistry which have tested the skill and resources of Britain's leading illuminating engineers and scenic experts, will flood the Grand Hall with colour and radiance that will transform its familiar outline as though with some fairy wand.

Dominating the City will be a silver pylon of light, the centre of a secret effect which, it is promised, will give a new beauty, dignity and even mystery to illumination. The City will disclose the story of the Evolution of Light on a scale of lavishness never hitherto attempted, and introduce many specially designed features which suggest entrancing further developments in the coming Age of Light.

ROYAL INSTITUTION.

At a meeting of the Members of the Royal Institution held on February 1, Sir Robert Robertson, Treasurer and Vice-President, in the Chair. The Chairman reported the death of Sir Alfred Yarrow and a resolution of condolence with the relatives was passed. Dr. C. D. Ellis, Professor L. C. Martin, Sir Philip Nash and Mr. H. C. Reynard were elected members.

roceedings and Notices of Societies

THE PHYSICAL SOCIETY.

January 15.

Some Thermomagnetic Effects in Nickel *ıd Iron.* By SHIH-CHEN T'AO, M.S. (enching) AND WILLIAM BAND, M.Sc., enching University, Department of ıysics, Peking, China.

The paper relates to the production of an m.f. in nickel and iron wires by the simulneous application of a longitudinal magtising field and a temperature gradient. ıis e.m.f. has been measured for various lds and temperatures.

On Periodic Movements of the Negative *ow in Discharge Tubes.* By MISS W. A. :YSHORN, Ph.D.

An account is given of experiments de-;ned to discover the cause of the jumping-ɔw phenomenon in discharge tubes. It is own that the effect is produced when ıces of hydrocarbon vapour are present the tube in addition to the filling gas eon, in most of the experiments here scribed). Some effects of such traces of pour on the characteristics of the tube are ren.

It is suggested that the phenomenon of ɜ jumping glow may be due to internal shing at that part of the surface of the thode which is not covered by negative ɔw. The flash may be caused by the eleccal breakdown of a partially insulating drocarbon layer, as a result of the collecn of positive ions, or by a surface chemi-. action occurring when the reaction-procts of the discharge have reached a cern concentration at that surface. It is ɔposed that the electron emissivity of the face is increased by the flash, and the ιin glow jumps to the activated surface. e process is reversible and hence may be riodic. Observations connecting the riodic time of jumps with the current rough the tube are in support of this planation, as also are other experimental ults described in the paper.

1 Cathode-Ray Oscillographic Method of *asuring Inductance.* By PROF. G. I. ʌCH, M.B.E., AND R. W. SUTTON.

The voltage fluctuations across the conıser in a damped oscillatory circuit, comsing inductance, capacity and resistance, : recorded by means of a cathode-ray ɜillograph. The following relationship is ived:

$$L=CV_1^2\{(1+\lambda+\tfrac{1}{2}+2/\pi^2)\lambda^2+(\tfrac{1}{6}+2\lambda^3/\pi^2)\lambda^3\}/i_0^2,$$

where L is the inductance, C the capacity, V_1 the first peak voltage across C in a train of damped oscillations, i_0 the primary current through L at break of a charging circuit and λ the logarithmic decrement of the oscillatory circuit. The measurement of V and λ from the oscillogram is discussed.

On the Measurement of Electrical Resistance in terms of a mutual inductance and a Period. By H. R. NETTLETON, D.Sc., AND F. H. LEWELLYN.

It is shown that if the ratio α/a of the radii of the concentric circles forming a simple inductometer is 0.50607_8, the mutual inductance is so accurately proportional to the angle through which the turning coil is displaced that the rising deviation from a linear law is less than 5 parts in a million at 7° of deflection. If the outer circle is replaced by two twin circles which are separated symmetrically with regard to the turning coil, the ratio α/a must be increased to bring about a similar approach to linearity.

If a heavy dynamometer is constructed on this principle, then, over the range indicated, the deflecting couple is strictly proportional to the current-products. Moreover, if such a dynamometer be damped electrically, the damping-couple is accurately proportional to the velocity and, over a range of oscillation of 14°, we have a remarkably close approach to true damped simple harmonic motion.

It is shown that the resistance of the oscillator circuit is very accurately given by the expression

$$R=\frac{CM}{c}\Bigg/\left[\frac{\lambda T}{\pi^2+\lambda^2}-\frac{\lambda_0 T_0}{\pi^2+\lambda_0^2}\right],$$

where λ is the logarithmic decrement and T the period on closed circuit of the oscillator when a current C traverses the field coils, while λ_0 and T_0 correspond to open circuit and M is the mutual inductance between the oscillating coil and the field coils when the former is in the position of steady deflection due to the passage through it of a steady current c, in conjunction with the circuit C through the field coils. This expression eliminates quantities difficult to measure in Weber's method. Experimental tests are described. Tables of Legendre and other functions, which facilitate the calculation of mutual inductances of the nature here considered, were exhibited.

THE FACULTY OF SCIENCES.

At a meeting of the Council held in London on Monday, the 8 February, the following candidates for admission to membership of the Faculty were duly elected Fellows :—

Hugh Aitken, Tumutumu, P.O. Karatina, Kenya Colony; Randolph Dodd, "Rodenhurst," Highview Road, Cheam, Surrey; Abdool Sumadh, 92, Cipero Street, San Fernando, Trinidad, B.W.I; William Ernest Cooper, 163, Wolverhampton Road, Quinton, Birmingham; William James Osborn, 12, West Square, St. George's Road, Southwark, S.E.1; Mitwally Sayed Chabasi, Chief Engineer, Municipality of Zagazig, Egypt; Mahmoud Bey Sabry, Director General, Ministry of Public Works, Cairo; Archibald William Hill Oakey, The Sanitary Office, Municipal Buildings, Haifa, Palestine; Nowrosji M. Bhathena, 31, Rebsch Street, Bycalla, Bombay, India; Anthony Aslamidis, 31, Barnfield Crescent, Ashton-on-Mersey, Cheshire; Alan Wardle Clarke, "Rock Lyn," Hurst Lane, Bollington, Macclesfield; Percival Harold Audsley, The Mount, Loftus, Yorks; Ralph Gordon Harry, 183, Cathedral Road, Cardiff; Harold Clayton, 12, Broadway Avenue, Cheadle, Cheshire; Herbert Samuel Durston, 155, Whiteladies Road, Bristol; Alexander Duncan Munro, The Municipal Council, Hamilton House, Nairobi, K.C. Archibald Wesley Pimm, "Bermersyde," 182, Milton Road, Weston-super-Mare; Herbert Veron Hawley, 314, Sassoon House, The Bund, Shanghai, China.

MINERALOGICAL SOCIETY.

Tuesday, January 19.

Sir John S. Flett, President, in the chair.

A New Pallasite from Alice Springs, Central Australia. By Dr. L. J. Spencer.

A fragment weighing 1,084 grams was collected by Dr. Herbert Basedow in 1924 on the north side of the MacDonnell Ranges about ten miles north of Alice Springs, and has been generously presented by him to the British Museum collection of meteorites. It is a typical pallasite consisting of 40 per cent. of olivine (with FeO : MgO = 4.6) and 60 per cent. of nickel-iron (Fe : Ni = 12.7) with a little troilite. Small angular fragments of olivine are embedded in the Tamacite, suggesting that the olivine had been broken up before the tamacite crystallised out. The granular texture of the metal also suggests that the kamacite had been broken up with the development of Neumann lines before the separation of the taenite and plessite, and that the fragments had been partly re-dissolved in the residual melt, giving the reaction-rim of taenite. Finally, the plessite eutectic separated out in the small interspaces.

An Account of British Mineral Collectors and Dealers in the Seventeenth, Eighteenth and Nineteenth Centuries. By Arthur Russell.

Short biographies dealing with Robert Were Fox (1789-1877), Wilson Lowry *(1762-1824), and Thomas Hogg.*

Studies on the Zeolites, Part III. Natrolite and Metanatrolite. By M. H. Hey.

Natrolite is shown by nine new analyses and new X-ray measurements to have a constant Si/Al-ratio and a unit-cell formula of $Na_{16}Al_{16}Si_{24}O_{80}.16H_2O$, in agreement with previous results. $Na_2 \rightarrow Ca$ replacement may occur up to about 4, and $Na \rightarrow K$ replacement up to about 2 atoms per unit-cell. Natural etch-figures in natrolite from Benallt, Carnarvonshire (a new locality for natrolite), show the symmetry to be didigonal polar (C_{2v}). A detailed study of the optical properties of natrolite has been made. Some observations have been made on the effects of partial dehydration on the optical properties. The vapour-pressure has been studied at various temperatures and degrees of dehydration, and a discontinuity in physical properties at a water content of 15 mols. per unit-cell observed. Some experiments have been carried out on the base-exchange of natrolite. Optical and X-ray examination of metanatrolite have been made.

Notices of Books.

Kolloidchemische Technologie. Ein Handbuch kolloidchemischer Betrachtungsweise in der chemischen Industrie und Technik. By Prof. R. E. Liesegang with the collaboration of many distinguished specialists. Second revised and enlarged edition, pp. 1085. Dresden and Leipzig: Theodor Steinkopff. 1932. Price 68 marks.

Prof. Liesegang's comprehensive treatise covering the whole field of Colloid chemical Technology first appeared in 1927 and it is gratifying to know that within five years

this specialist work of relatively limited appeal has passed into a second edition. Colloid phenomena enter so largely into chemical and industrial process and the boundaries of the subject are ever widening. The mere list is bewildering and includes, active carbons, soaps, cleaning preparations, lubricants, textiles, artificial silks, paper, dyes and their application, inks, glue and gelatine, adhesives, tanning, plasticisers, rubber, insulators, asphalts and tars, ceramics, cements, glass, water technology, emulsions and petrols, milk, lipoids, sugar technology, flour and bread, brewing, fertilisers, metallurgy and photography.

Compared with the first edition the present one has been extended in many sections to admit of new matter being introduced; a few sections have been adapted from separate monographs by some of Prof. Liesegang's co-workers. In a brief notice of so monumental a work it is very difficult to select any particular section for special commendation. The whole work is so thorough and complete and has evidently been revised with extreme care and will be the standard volume on the subject of applied colloid chemistry for years.

Forthcoming Events.

FRIDAY, FEBRUARY 12.

ROYAL INSTITUTION. 21, Albemarle St., W.1., at 9 p.m. "Petroleum: A Record of Achievement in Applied Science," by Sir John Cadman.

COKE OVEN MANAGERS' ASSOCIATION. *Midland Section.* Grand Hotel, Sheffield, at 6.30 p.m. "Micro-Structure of Bituminous Coal," by Mrs. C. P. Finn.

CHEMICAL ENGINEERING GROUP. Burlington House, Piccadilly, W.1., at 8 p.m. "New Method of Measuring the Mechanical Properties of Metals," by L. H. Hounsfield.

S.C.I. *Glasgow Section.* Royal Technical College, Glasgow, at 7.30 p.m. Jointly with Glasgow Chemical Societies. "Significance of Valency as Elucidated by a Study of the Solid State," by Sir Wm. H. Bragg, F.R.S.

S.C.I. *South Wales Section.* Joint meeting with the local section of the Institute of Chemistry. Thomas' Cafe, Swansea, at 7.30 p.m. "Paint and Varnish Industry," by Dr. D. G. Hopkins.

INSTITUTE OF METALS. *Sheffield Section.* University, Sheffield, at 7.30 p.m. "Spectrographic Methods of Chemical Analysis," by Dr. H. W. Brownsdon and E. H. S. van Someren.

INSTITUTE OF BREWING. *North of England Section.* Annual General Meeting and Dinner. Midland Hotel, Manchester.

BIOCHEMICAL SOCIETY. Lister Institution, Chelsea Bridge Road, S.W.1. "Structure of the Protein Molecule," by D. Jordan Lloyd and H. Phillips. "Oxidation of Glucose by Glucose Dehydrogenase," by D. C. Harrison. "Reduction of Glutathione by a Liver System," by P. J. G. Mann. "Complex Nature of Glucose Dehydrogenase," by P. J. G. Mann. "Treatment of Carotene and Vitamin-*A* Concentrates with Antimony Trichloride," by A. E. Gillam, R. A. Morton, I. M. Heilbron, and J. C. Drummond. "Effect of 7-Methyl Indole on the Antimony Trichloride Colour Test in Relation to Vitamin-*A*," by R. A. Morton. "Characteristics of Highly Active Vitamin-*A* Preparations," by I. M. Heilbron, R. N. Heslop, R. A. Morton, J. C. Drummond, and J. L. Rea. "Palladous Chloride as a Reagent for Purine Derivatives," by J. M. Gulland and T. F. Macrea. "Spermicidal Action of Quinones," by J. M. Gulland. "Alleged Synthesis of Vitamin-*C*," by S. Smith and S. S. Zilva.

TUESDAY, FEBRUARY 16.

ROYAL INSTITUTION, 21, Albemarle Street, W.1., at 5.15 p.m. "Crystal Analysis," by Sir William Bragg.

WEDNESDAY, FEBRUARY 17.

SOCIETY OF GLASS TECHNOLOGY. Joint Meeting with the Ceramic Society will be held in Sheffield.

S.C.I. *Montreal Section.* Mount Royal Hotel, Montreal, at 8 p.m. "Our Present Knowledge of Coal," by Dr. H. Curtis.

INSTITUTE OF FUEL. Burlington House, Piccadilly, W.1., at 6 p.m. "Properties of Coals as Controlled by their Composition," by Prof. G. Hickling.

INSTITUTE OF CHEMISTRY. London and *S.E. Counties Section.* Lecture by Prof. H. E. Armstrong.

THURSDAY, FEBRUARY 18.

ROYAL INSTITUTION, 21, Albemarle Street, W.1., at 5.15 p.m. "Heredity in Man," by J. B. S. Haldane.

THE CHEMICAL NEWS

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Chemical Research as an Insurance Against Depression in Industry.

(From our New York Correspondent.)

According to a survey of the economic situation in the American Chemical Industry made by the American Chemical Society, it has been proved that research has been a means of assisting many large trading organisations to escape the devastating influences of the general depression. Apparently mindful that those companies which retained their scientific organisations during the trade slump of a decade ago, were the leaders in the prosperity which followed, the American Chemical Industry as a whole, has preserved its research staffs in preparation for the upward trend in business which is believed to lie ahead.

For this reason, it is pointed out, there is less unemployment among chemists than among other professional groups. Establishment of the six-hour day in the industry has stretched the payrolls over a greater number of workers. Several instances of courage in launching new enterprises are reported in the survey. One concern even increased wages.

"It would be unjustifiably optimistic to anticipate that we are going forward to any such period of artificial prosperity as characterised the years preceding 1930, but one may also discount the dismal prophecies of others who see nothing but thick gloom ahead for many years to come," it is declared.

"In the chemical industry as in all others we find a narrowing of markets and a tightening of the belt in preparation for eventualities. Under the circumstances it is to be expected that fear of the huge expenses involved in launching new ventures has minimised the number of these pushed out of development into production during the year, and that despite every good intention many corporations have been forced to reduce their payrolls. Unemployment has been both a result and a cause of this financial stringency.

"Among chemists and chemically trained workers of what might be considered professional standing, the extent of unemployment has been small compared with other groups, presumably because the last decade

has firmly implanted the lesson of 1921 in the minds of executives. In 1921 research departments were still considered more or less extraneous to the real business of manufacture and sale of commodities, and consequentlywere jettisoned at the first indication of a storm.

" In the period that followed, business battles were won so consistently by the best research organisations that this activity has now been closely integrated into an essential position in corporate structures. At the same time men with research training have risen to posts of responsibility in corporate affairs so that research workers now have friends at court in a way that they did not have before.

" Consequently during the present disturbance, research has occupied a preferred position, with insurance and other essentials at the bottom of the list of slashes instead of near the top. While production and even sales forces suffered in 1930, research staffs were held practically intact well into 1931, and even then were pruned with great caution.

" Although there have been exceptions to this rule, generally the reduction of research forces has been a pruning process rather than a deforestation. Under such circumstances one is gratified to find the membership of the American Chemical Society shows a relatively low percentage of unmployment.

" Whatever statistics one may gather, the fact of unemployment and consequent suffering cannot be wished away. While the number of unemployed chemists is not great, the average period of idleness for each is far above normal.

" During normal periods the number of unemployed may be a considerable proportion of the present figure and each of them may anticipate an average period between employments of not more than one or two months, whereas in the present situation the average interval of idleness is increased by the same factors which reduce the number of unemployed, to several times this length of time. In other words, the present effect is multiplied in its consequences by the time factor.

" To assist in re-employment, local sections of the Society are organising and operating committees made up of the unemployed themselves to assist in the problem of finding and creating openings. The New York and North Jersey Sections, where movement.

" Many anomalies have developed as a result of these conditions. It is difficult to reconcile the efforts of employers, particularly in the chemical industry, to adopt a six-hour day to allow more men to remain gainfully employed, with the strike of some 35,000 textile workers in New England against a reduction of pay.

" The six-hour day, promulgated in the chemical industry by the Manufacturing Chemists Association, has been put satisfactorily into effect by a number of leading chemical companies and has served to stretch payrools over a greater number of workers.

" The striking textile employees after weeks of futile negotiation attempted finally to return to work only to find that demand for their services had materially diminished, and that managements were reluctant to make any sacrifices to re-employ them.

" We have, too, the striking picture of one organisation, the Monsanto Chemical Company, raising wages when everyone else was reducing payrolls, or grimly fighting to prevent doing so. This corporation explained its move as a substantial acknowledgment of loyalty which it made for the purpose of raising morale. It is most unfortunate that others did not, or could not, follow this lead.

" Four new ventures launched into commercial reality against the tremendous industrial inertia of 1931 justify special comment. They stand out as clear indications of the courage of their promoters.

" The United States Potash Company, a subsidiary of the Pacific Coast Borax Company, put into operation early in the year its mine near Carlsbad, New Mexico. This mine, the only shaft mine operated for potash in America yields sylvite (potassium chloride) from a depth of 1,200 to 1,400 feet of sufficient purity for sale as manure salt after simple grinding and without concentration.

" The output of this mine has been maintained at a rate of several carloads per day since early spring. The deposit being worked is reported to be enormous and apparently is in a similar formation to deposits found farther south in Texas at a greater depth.

" The Southern Mineral Products Company, a subsidiary of the Vanadium Cor-

poration of America, began production of titanium oxide pigments and other chemicals at Piney River, Va., in April. This plant operates on ore locally produced and turns out high-grade pigment. The ore, nelsonite, is an aggregate of ilmenite and apatite containing magnetite, and is obtained from an open-cut mine. In addition to titanium oxide the plant produces phosphoric acid and phosphates.

"In November, E. I. du Pont de Nemours and Company announced their new product, 'Duprene,' a synthetic rubber. This material is being produced at Deepwater Point, N. J., in commercial quantites. Its present field of usefulness depends upon its resistance to water and hydrocarbon solvents suggesting its utilisation in hose, rubber valves, etc., for such liquids. Further applications are to he expected.

"The finished product contains chlorine and requires no sulphur for vulcanisation. The fundamental work on which this development is based was initiated and conducted by and under the direction of J. A. Nieuwland of the University of Notre Dame.

"In connection with this development, it is interesting to note that a small piece of synthetic rubber, believed to be the first ever to be made from petroleum as a raw material, was exhibited in the booth of the American Chemical Society at the 1931 Chemical Exposition. The sample was prepared by B. T. Brooks and was, chemically, rubber. Duprene is a rubber-like synthetic rather than synthetic rubber.

"The fourth commercial development of special interest was the beginning of operations by the Standard Chromates Company at Painesville, Ohio, manufacturers of sodium dichromate."

SOLID SAL AMMONIAC SHIPPED FROM GERMANY.

There is comparatively large production of solid sal ammoniac in Germany, a great percentage of which is used for cleaning and tinning soldering coppers. Although no statistics are available on the production of this compound exports during the first nine months of 1931 were 17,000 metric tons of which 7,900 tons were shipped to Belgium, 2,000 to the Netherlands, 1,900 to France, 1,170 to the United Kingdom, and 970 to the United States.

EFFICIENT CASE-HARDENING AT HIGH SPEED.

OR "WHILE YOU WAIT" AT THE BRITISH INDUSTRIES FAIR.

The Cassel Cyanide case-hardening process which will be demonstrated on Stand No. 15 C/8 at the Birmingham Section of the British Industries Fair, is of equal interest to the manufacture and to the small engineer or mechanic.

In these days, increased speed of production is the aim of every manufacturer but the saving of time effected by the use of free-cutting steels and automatic machine tools and by careful organisation is often off-set in the hardening shop. Here time is lost in packing the articles in the compound, luting the boxes and in heating-through the non-conductive cement. This usually takes not less than an hour.

Hardening by the Cyanide process dispenses with all this. Work can be hardened to a depth of 1/64″ within one hour of leaving the automatic or to a depth of 1/32″ in 2½ hours. This obviates delay or congestion in the hardening shop. The remarkable speed of the Cyanide case-hardening process is one of the reasons for its steadily increasing popularity.

The latest developments of the process will be shown in operation at Birmingham and visitors to the Fair may also bring their own small metal parts, such as pins, bolts, cups or washers, to be case-hardened while they wait. They will be surprised to find that soft objects are completely covered with a glass-hard case after five or ten minutes' immersion in the molten material in the furnace.

The plant required to operate the Cyanide process is simple. The Standard self-contained portable unit which occupies a floor space of 27″ × 27″ with a height of 6′ 6″ to the top of the canopy will take 50 lb. of machine parts at a charge. This furnace has such recuperative capacity that it will bring its full load to the carburising temperature of 950° C. within 20 minutes to half-an-hour. A pyrometer supplied with the unit records the actual temperature of the molten mass of sodium cyanide and thus the carburising temperature of the steel parts is kept constantly before the operator. By simple adjustment of the gas supply this temperature can be maintained with very minor variation throughout the whole period of treatment.

PROBLEMS CONFRONTING THE SPRAYER.

I.—THE VOLUME OF LIQUID NEEDED TO SPRAY TREES OF VARYING SIZES AND SHAPES.

By C. W. B. WRIGHT AND R. M. WOODMAN.

Despite the fact that spraying is usually one of the mostly costly operations in a properly-conducted orchard, little work has been done on the actual expense involved; the most searching and ambitious investigation of this difficult problem made in England up to the present time is probably that contained in a paper by Turnbull,[1] in which figures are arrived at for the cost of spraying an orchard.

The authors, whilst recognising that Turnbull has carried out an important pioneer investigation on this problem, are inclined to think that, before any such figures can be given, a great number of preliminary points demand attention. Such a problem as the amount of spray fluid necessary to "cover" a tree of a certain variety and size appears inevitable as a first step to this work, and the present paper describes an attempt to obtain a standard expression for this amount.

THE SIZE OF A TREE.

Before proceeding to find the volume of liquid required to cover a tree, it is imperative to obtain some measure of the size of that tree, preferably from simple, practical observations. Shape—determined to a great extent by variety as modified by pruning to a stereotyped form—is, without doubt, an important factor in determining size; for this reason, after making an inspection of large numbers of trees, approximate outline drawings were made of the cross-sections of most of the different shapes likely to be met with in English practice, a reproduction of these being given in Fig. 1. The drawings are meant as type shapes; a cursory glance at the trees in an orchard will show to which type the majority of the trees of any one variety belong.

The fixation of the size of a tree, though important in many horticultural experiments, is a difficult problem; the question arises—What shall be taken as a measure of size?

Turnbull (*loc. cit.*), for the purpose of ascertaining spraying costs, has, in a manner, taken area as proportional to the size of the tree, for he states that "the conditions selected for this inquiry were . . . . trees . . . . of such a size that they were just touching." Size of tree has also often been defined by such simple measurements as height, width, etc., though linear measurements such as these are often apt to be very misleading. There are, however, two more difficult measurements which would seem to merit attention: these are the volume of, and the outer surface of, the head of the tree.

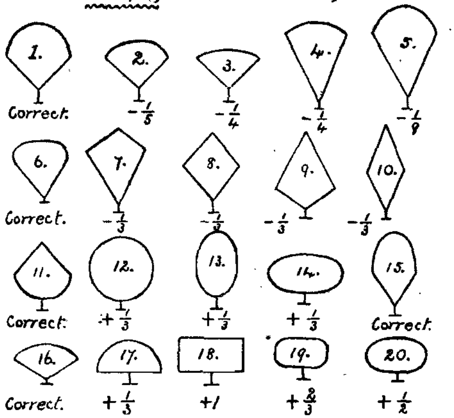
At first glance, it might seem that, in questions of spraying, the external surface of the head is much more important than the volume, for spraying carries with it the notion of covering a surface. Although this might be a reasonable supposition when the tree is in full foliage (as some of the results quoted later would tend to indicate), it will be seen that volume is probably a better criterion of size, particularly when the tree is leafless or has scanty foliage, as in winter and spring spraying. It was decided, therefore, to take the volume of the head of a tree as a criterion of size.

The absolute volume of the head of a tree would not be a quantity susceptible of easy measurement; for this reason a relative quantity—called hereafter a volume number (vol. no.)—was chosen as a measure of the absolute volume. The volume number (V) of any tree was found by substitution in the equation $V = ab^2$, where a = the height of the head (total height of the tree minus the length of the leg from ground level to the head or crown), and b = the greatest width of the tree.* The fit of this equation to the types of head-shapes shown in Fig. I was

[1] Turnbull, *Ministry of Agriculture and Fisheries Miscellaneous Publications,* No. 58.

* Straggling twigs falling outside the average shape were neglected. The equation is not sufficiently accurate to warrant the average of a large number of measurements of width. In actual practice it is better to allow commonsense to dictate what exceptional twigs and

FIG. I, (ADJUSTMENT TABLE):



tested; " correct " means that the equation yields a volume number for that shape of head sufficiently accurate for practical purposes, whilst a fraction preceded by + or − indicates the correctional fraction of the volume number to be added to, or subtracted from, the volume number derived from the equation.

A ready reference table for ascertaining the volume numbers of trees at a glance from these simple measurements can easily be constructed.

EXPERIMENTAL.

Groups of trees of several varieties were sprayed when the foliage was at different stages of growth, the spraying being done by means of a hand-power barrel pump connected to a six-foot lance, the nozzle of which was a " medium " one;† the same apparatus was used throughout the whole series of experiments.

*The wash used consisted of soft dyke-*water made up to contain 0.75 per cent. of fish-oil soft soap, this easily wetting and running over the plant surfaces. The sprayer himself was left to judge when the trees were thoroughly wetted, so as to reduce personal error, the authors standing by to notice peculiarities in the spraying of any particular group of trees.

The volume of wash put on a group of trees was obtained accurately in every case by subtracting the measured residue left in the barrel after a spraying, from the volume initially placed in the barrel. The volume numbers of all trees sprayed were calculated and tabulated as Table A, and the results were worked out as (*a*), the volume of wash needed to spray 1000 volume number of trees of any variety and, (*b*), the average volume of spray needed to spray one tree of that variety. These results are given in Table B; some are illustrated graphically in Fig. II.

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branches to neglect. The nearest half-foot is quite a sufficiently accurate measurement usually (and the nearest foot for large trees), taking about five trees in a batch at least.

† The questions of pump pressure, size of nozzle and type of wash are now receiving the authors' attention. It was intended to allow the same sprayer to do all spraying; unfortunately the man who did the 20/4/27, 5/5/27 and 7/5/27 sprayings was involved in an accident, his brother doing the remainder.

DISCUSSION OF RESULTS.

It will be noticed that random samples of trees were chosen first; this was on the assumption that a 1000 volume no. of any tree of any variety would require the same volume of wash approximately. This assumption was found to be fallacious, various factors appearing to influence the amount of spray necessary. (It is noteworthy, however, that bush trees of Derby and Worcester, approximately of the same habit owing to pruning, and at the same state of foliage on 5-7/5/27, required the same volume of spray (102-104 pints) per 1000 vol. no., though the trees were random samples; this appears to give some basis for the vol. no. method chosen).

In the first place it will be observed that the development of the foliage plays a large part in modifying the amount of spray necessary to "cover" a tree. The first spraying on 20/4/27 practically corresponds to winter spraying; as the foliage develops, the volume of liquid per 1000 vol. no. of tree for any given variety (keeping the average vol. no. per tree practically constant) usually rises to a maximum and then decreases with later successive sprayings, the date of the maximum volume being, of course, influenced by varietal habit.

This may be accounted for as follows: when the trees are bare, or nearly so, branches and twigs on the inside of the tree are thoroughly sprayed, for unwetted wood is easily perceived; as foliage is developing, it is also easy to perceive whether the leaves are thoroughly wetted, and consequently an extra amount of spray is used for these leaves; but when the foliage is heavy, the tendency is *to wet the external surface of the head of the tree only*, the internal branches and twigs escaping notice, much less spray per tree or per 1000 vol. no. of tree being used for any given variety.

Another important factor influencing the volume of spray used per 1000 vol. no. is noticed in the results for 7-8/6/27, where trees fully developed as regards foliage were sprayed in groups so that the vol. nos. of the individual trees in any group agreed with the average vol. no.

The necessary number of pints per tree for any given variety was naturally found to increase with increase in the average size of the tree in passing from group to group, but the amount of spray per 1000 vol. no of tree decreased continuously. The reasons are evident when close attention is given to the act of spraying: in the case of abnormally small trees, such as the small Lanes

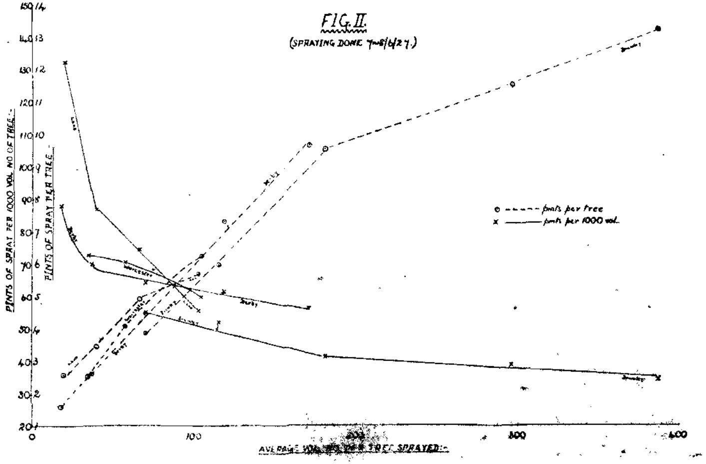

FIG. II.
(SPRAYING DONE 7-8/6/27.)

(all less than 4-5ft. high), the sprayer directs the lance downwards, thoroughly wetting every portion of the tree; but, in doing this, the sprayer runs up and down every branch and large twig, thereby causing great waste as the surfaces intercepting the spray at any moment are small. On the other hand, when spraying large trees such as fully-developed half-standard Bramleys (about 12ft. high), the sprayer tends to " throw " the spray at the top portions of the tree, and, as he cannot see properly, assumes these portions perfectly wet when they are not; the outer surface of the top portion is probably barely wet. A second factor tending to the use of less spray per 1000 vol. no. as the individual trees in a group become larger is the presence of thicker branches

TABLE A.

Variety and key nos. of trees	Vol. nos. of trees	Variety and key nos. of trees	Vol. nos. of trees	Variety and key nos. of Trees	Vol. nos. of Trees	Variety and key nos. of Trees	Vol. nos. of Trees
Lord Derby		Worcester Pearmain		Lane's Prince Albert		Bramley's Seedling	
1	136	1	56	1	13	1	801
2	139	2	80	2	18	2	197
3	124	3	20	3	24	3	164
4	02	4	43	4	16	4	277
5	72	5	38	5	17	5	155
6	100	6	53	6	17	6	879
7	84	7	59	7	26	7	120
8	74	8	53	8	24	8	368
9	98	9	53	9	72	9	327
10	77	10	40	10	59	10	109
11	111	11	116	11	61	11	259
12	77	12	66	12	75	12	186
13	166	13	99	13	151	13	209
14	77	14	128	14	86	14	173
15	173	15	65	15	97	15	428
16	187	16	80	16	115	16	876
17	110	17	90	17	34	17	487
18	135	18	100	18	45	18	320
19	58	19	90	19	45	19	85
20	189	20	80	20	38	20	73
21	92	21	100	21	39	21	70
22	18	22	97	22	39	22	60
23	18	23	110	23	100	23	85
24	14	24	45	24	110	24	70
25	23	25	29	25	90	25	50
26	13	26	29	26	65	26	115
27	22	—	—	27	65	27	118
28	18	—	—	—	—	28	115
29	178	—	—	—	—	—	—
30	178	—	—	—	—	—	—
31	157	—	—	—	—	—	—
32	29	—	—	—	—	—	—
33	88	—	—	—	—	—	—
34	45	—	—	—	—	—	—
35	29	—	—	—	—	—	—
36	84	—	—	—	—	—	—
37	45	—	—	—	—	—	—

Variety.	Date of Spraying.	Key Nos. of Trees Sp									
Worcester Pearmain	20/4/27	1	2	3	4	5	6	7	8	9	1(
do.	7/5/27 *	1	2	3	4	5	6	7	8	9	1(
do.	23/5/27	1	2	3	4	5	6	11	12		
do.	7-8/6/27	2	3	4	5	10	24	25	26		
do.	do.	1	6	7	8	9	12	15			
do.	do.	11	13	14	18	19	21	22	23		
Lord Derby	20/4/27	1	2	3	4	5	6	7	8	9	1
					16	17	18	19	20	21	
do.	5/5/27	1	2	3	4	5	6	7	8	9	1(
					19	20					
do.	28/5/27	1	2	3	4	5	6	7	8	9	1(
do.	7-8/6/27	22	23	24	25	26	27	28			
do.	do.	32	33	34	35	36	37				
do.	do.	4	5	8	12	14	19				
do.	do.	1	2	3	6	9	11	17	18		
do.	do.	13	15	16	29	30	31				
Bramley's Seedling	20/4/27	1	2	3	4	5	6	7	8	9	1(
do.	5/5/27	1	2	3	4	5	6	8	9	10	11
do.	do.	15	16	17							
do.	28/5/27	1	2	3	4	5	10	11	12	13	
do.	7-8/6/27	19	20	21	22	23	24	25			
do.	do.	7	10	26	27	28					
do.	do.	2	3	5	12	13	14				
do.	do.	1	4	9	11	18					
do.	do.	6	8	15	16						
Lane's Prince Albert	20/4/27	1	2	3	4	5	6	7	8		
do.	5/5/27	1	2	3	4	5	6	7	8		
do.	do.	9	10	11	13	14	15	16			
do.	28/5/27	1	2	3	4	5	6	7	8		
do.	7-8/6/27	1	2	3	4	5	6	7	8		
do.	do.	14	17	18	19	20	21	22			
do.	do.	9	10	11	12	26	27				
do.	do.	15	16	23	24	25					

* Sprayed two days after the other varieties as the number

		Total Vol. No. of Trees Sprayed	Average Vol. No. per Tree Sprayed	Total Vol. of Spray used (pints)	Pints of Spray per 1000 Vol. No.	Average Vol. of Spray per Tree (pints)
14	15	914	60.9	83.5	91.41	5.57
14	15	914	60.9	95.0	104.0	6.33
		422	52.8	52.5	124.4	6.56
		275	34.4	20.0	72.68	2.50
		403	57.6	28.5	70.65	4.07
		885	104.4	50.0	59.84	6.25
14	15	2284	108.8	194.0	84.94	9.24
17	18	1872	110.1	191.5	102.3	11.27
18	19	1623	108.2	160.0	98.58	10.67
		125	17.9	11.0	87.78	1.57
		221	36.8	15.5	70.09	2.58
		420	70.0	27.0	64.31	4.50
		947	118.4	58.5	61.79	7.31
		1028	171.3	58.0	56.39	9.67
14		3223	230.2	191.0	59.24	13.64
		3104	238.8	178.5	57.49	13.73
		1291	430.3	81.5	63.14	27.17
		1856	206.2	98.5	53.04	10.94
		492	70.3	27.0	54.88	3.86
		576	115.2	30.0	52.01	6.00
		1083	180.5	44.5	41.06	9.58
		1484	296.8	57.5	38.75	11.50
		1551	387.8	53.0	34.18	13.25
		155	19.4	26.0	167.9	3.25
		155	19.4	31.5	203.3	3.94
		590	84.3	63.5	107.6	9.07
		155	19.4	33.0	213.0	4.13
		155	19.4	20.5	132.3	2.56
		277	39.6	24.0	86.70	3.43
		396	66.0	29.5	74.50	4.92
		511	102.2	28.5	55.68	5.70

on 5/5/27 was open to question.

and main twigs; these intercept a great deal of spray by presenting a larger surface, causing thus less waste.

Exception, of course, might be taken to the statement that, in spraying, the topmost portions of a tree only 12ft. high are not thoroughly wetted.* The fact remains that often, when trees have been sprayed for caterpillar in spring or summer (or even in winter with an ovicidal wash), any subsequent caterpillar damage is usually at the top of the tree, pointing to insufficient "cover" in that portion. The usual and natural objection to this statement is that the spray has dripped from the upper surfaces of the tree on to the lower surfaces, thereby being inefficient at the top but keeping the lower portion clear of caterpillar.* This objection is unsatisfactory: besides assuming that the lower half of the tree is kept clean mainly fortuitiously by drippings—and thus indirectly throwing some doubt on the act of spraying itself, and causing one to wonder why *all* the spray is not directed to the top of tree—it is difficult to perceive how this drip could account for the freedom from caterpillar pests of the lower halves of trees with shapes such as Nos. 9, 10 and 11 (Fig. I).

It will be noticed from the graphs in Fig. II, that, though the number of pints per 1000 vol. no. of tree depends on the size of the tree sprayed, the variation is moderately regular, and can be calculated easily over the ranges Derby, vol. no. = 36—170, Worcester, vol. no. = 34—104, Lane, vol. no. = 30—102, Bramley, vol. no. = 180—388; these ranges *include* all those sizes which would normally be met with in orchards containing Derby, Worcester and Lane bush trees, and Bramley half-standards.

* In support of this statement, Mr. F. R. Petherbridge, M.A., has informed me that to wet the top half of a tree thoroughly, much more spray is needed relatively than for the lower half, pointing to greater waste in attaining this thorough wetting. The argument in the text, of course, refers to spraying by the average workman sprayer, who, as stated, assumes the top half wetted when it is not. There must, incidentally, be a certain amount of protection afforded always to some portions of the lower half by drippings from the upper half.

The preliminary experiments described in this note show that the calculation of the volume of spray necessary to cover an acre of trees will be a matter of great difficulty, for, as regards the influence of the tree itself, variety, size and state of development of foliage must be taken into account even when the spray used is stated in terms of a unit volume of tree.

In conclusion, the authors thank Mr. C. E. Francis, M.A., formerly University Lecturer in Mathematics at Cambridge, for his help in working out the "fit" of the formula used to the shapes given in Fig. I, and Mr. T. Blofeld, M.A., who allowed the experiments to be carried out on his fruit farm at Hoveton, Norfolk, and who provided the necessary materials and labour.

SUMMARY.

It is shown how, from two simple linear measurements made on the "head" of an apple tree, a number ("volume number") relative to the absolute volume of the head can be calculated by the aid of a simple formula; corrections for the fit of this formula are given for all shapes of trees likely to be met with in practice.

The volume of spray used per tree varies with the development of the foliage; with increasing foliage the volume of spray at first tends to become larger, reaches a maximum, and then decreases with full foliage.

For any given variety and shape of tree, the volume of spray used per tree also naturally increases with increase in the size of the tree; this variation is moderately regular and can be calculated for normal sizes of the varieties used. But the spray used per unit volume of tree decreases with the size of the tree, and appears to be connected with the difficulty of thoroughly spraying the topmost portions of large trees and also with the larger branches.

Horticultural Research Station,
School of Agriculture,
Cambridge University.

EXEMPTIONS FROM KEY INDUSTRY DUTY.

The Treasury have made an Order under Section 10 (5) of the Finance Act, 1926, exempting phloroglucine from Key Industry Duty from 24 December, 1931, to 31 December, 1932.

The Treasury Order will shortly be published by the Stationery Office.

THE OTHER RUSSIA.

Much attention has recently been given to the not inconsiderable changes and developments that have been taking place in Soviet Russia. The U.S.S.R. with its 160 million inhabitants covers an immense area and few beyond specialists in Russian affairs acquire more than a very superficial knowledge of the country and its people. On the other hand, there is, in the extreme east of Czechoslovakia a small autonomous province of 4,886 sq. miles and 600,000 inhabitants attached to that republic and known as Subcarpathian Russia. It is inhabited by Ruthenes who speak a Russian dialect and still use the Cyrillic alphabet. Little is known about Subcarpathian Russia, although it is accessible enough to travellers to Czechoslovakia, and so a recent work by Mr. K. Kochannyj-Goralcuk,* one of its leading men of culture is therefore very welcome.

Mr. Kochannyj-Goralcuk deals in detail with the past and present of this other diminutive Russia as one of those determined to see it attain a more important position than it has hitherto enjoyed. Subcarpathian Russia is sparsely peopled, chiefly with Ruthenes, although most of the businsss in the towns is in Jewish hands. It is mountainous, covered with forests of both pine and hard woods, and where forests have been cleared, various crops (rye, oats, maize, barley and hemp) are raised and cattle bred. The chief industry is the timber trade, then comes agriculture and it would perhaps be considered unlikely that any chemical or allied industry could be conducted in this undeveloped land. Yet the last few years have seen a vast transformation. At Perecin, near Uzhorod, the capital, there is a large chemical works for the destructive distillation of wood, under Czech and German management, and which produces charcoal tar, acetic acid, acetone, methyl alcohol and gas. The charcoal is sent to the Silesian iron smelting works, acetic acid, acetates and acetone are readily disposed of to the artificial silk manufacturers and munition works.

* *Podkarpatská Rus (Subcarpathian Russia).* By K. Kochannyj-Goralcuk. Pp. 160. Prague: State Printing Works. 1931. Price 7 crowns 50 h. (1s. 8d.).

The Carpathians are not rich in minerals, but at Slotinské Doly there is an important salt deposit which yields some 100,000 tons annually, *i.e.* enough for domestic needs, including the chemical and soap factories at Usti-nad-Labem (Aussig a.d. Elbe) in Bohemia.

Oil borings have been made near the Polish frontier and there are considerable kaolin deposits which, however, must await better times and better transport facilities before they can be fully exploited. In the Berehovo districts there are extensive vineyards and the State wine cellars produce several types of wine and, of course, byproducts as well.

Mr. Kochannyj-Goralcuk has traced in his volume, the history of Subcarpathian Russia from earliest times to the present day. He deals with its trade, industry, husbandry, finance, art, literature, language, education, religion, and culture.

Those who have visited the country in recent years can testify to the enormous progress made during the last decade. Subcarparthian Russia will eventually rank as an important autonomous province of the Czechoslovak Republic.

J. G. F. Druce.

Obituary.

MR. P. M. REA, F.S.S., M.J.I.

It is with deep regret that we have to record the death of Mr. P. M. Rea, who, until May, 1931. was chairman and managing director of The Chemical News, Ltd. During the period in which Mr. Rea guided the destinies of this paper, the times were fraught with obstacles, trade depression, international feeling running high, and circulation affected as a consequence. In days of trial, a stout heart and sound health are needed by the helmsman and, whilst Mr. Rea undoubtedly possessed the former, due in a great degree to his Irish breed, his health had been impaired for some years before his decease. Mr. Rea was for many years chairman of the Hearts of Oak Assurance Company, Ltd., and nearly 50 years ago founded that well-known insurance paper, *The Agents' Journal.* Our deepest condolences go out to his family in their sad bereavement.

NON-FERROUS METALS IN DOMESTIC ARCHITECTURE.

COPPER ROOFS AND NICKEL CEILINGS.

A model house to demonstrate both the utility of and the decorative effect obtainable with modern forms of non-ferrous metals will be the central attraction on the stand of I.C.I. Metals, Ltd., at the Birmingham branch of the British Industries Fair.

I.C.I. Metals, Ltd., are the largest manufacturers of non-ferrous metals in Great Britain and will show specimens of brass, copper, cupro nickel, bronze, etc., in the form of sheet, strip, wire, rod, tubes, and extruded sections; and as illustrating the usefulness of non-ferrous metals, finished goods produced from these materials by I.C.I. customers.

The non-ferrous metal house is panelled in copper and other alloys of this metal, has a copper roof, and in one of the rooms a nickel ceiling. There is a complete hot water system showing the use of copper for pipes and boilers in a modern house.

The stand will be lit by an intensive system of floodlighting and will also show a copper firebox for a locomotive and a series of condenser plates and tubes such as are used for power stations and in all the great steamships of to-day.

The exhibit is intended to show the degree to which non-ferrous metals are necessary in present-day life, from an enormous condenser plate to the domestic pin.

PRAGUE SUMMER SCHOOL.

The promotors of the Prague Summer School have evidently taken the courageous view that political and economic crises will have subsided by midsummer, for they have planned that the School shall be held for the third year in succession, from July 11 to July 20, immediately after the International Gymnastic (Sokol) Display in Prague. They also anticipate an appreciation in the value of sterling, since the fees are fixed at 250 crowns, or 8 dollars, or £2. Nominally the pound is equivalent to 164 crowns, but to-day's rate is 112.

The time table of subjects, lectures, visits and excursions has been issued and can be obtained from Dr. Trnka, 55, Smetana Sq., Prague, Czechoslovakia. The course covers a variety of subjects, and it is hoped that not only will teachers and others enrol, but that visitors to the Czechoslovak Spas will combine their stay with attendance at the

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

February 4, 1932.

The following papers were read :—

Factors Affecting the Breeding of the Field Mouse (Microtus hirtus), I—Light. By J. R. BAKER and R. M. RANSON. Communicated by E. S. Goodrich, F.R.S.

The shortening of the daily period of exposure to light from fifteen hours to nine hours almost stops reproduction in the field mouse, *Microtus hirtus.* It is the female that is chiefly affected.

Modification of Mammalian Sexual Cycles; Re-actions of Ferrets of Both Sexes to Electric Light Added after Dark in November and December. By T. H. BISSONNETTE. Communicated by F. H. A. Marshall, F.R.S.

Male and female ferrets were subjected to doses of electric light during the night between October and January. Full oestrus was induced in the females in 38-64 days and successful coitus in 59-70 days. In the males interstitial cells were stimulated and copulation took place in 59 days, but no mature sperms were found even after 71 days. Birds differ from mammals in that the males are more responsive to doses of light than females. It is suspected that, with both bird and mammals, light may act through modifying anterior lobe activity, or susceptibility to it.

The Analysis and Synthesis of some Diseases of the Mosaic Type. The problems of Carriers and Auto-infection in the Potato. By R. N. SALAMAN. Communicated by Sir H. H. Dale, Sec.R.S.

As a result of both analytical and synthetic methods it has been possible to ascribe compositions in terms of X, Y, and Z to certain definite clinical virus diseases. In this way such clinical pictures as Interveinal Mosaic, Crinkle "A," and Paracrinkle have been built up.

The reaction of a virus complex is not the mere summation of that of its two constituents, but rather a linked group whose strength varies according to the complex and the internal environment of the plant.

At times a complex may break up either in an infected or a carrier plant, and one or other element becomes recognised as such. If this takes place in a carrier plant it is

The Origin of Erythrocytes in Herring (Clupea harengus). By C. C. JOHN. Communicated by E. W. MacBride, F.R.S.

During the first five months of development, Herring is devoid of red blood. The demersal egg hatches into a tiny larva in which the heart is at first a simple two-walled tube divided into two parts by a narrow constriction in the middle. The vascular fluid is colourless and does not contain any corpuscles. From deep water the larva migrates into mid water, and later to the coast. During this period the endocardium develops into a syncitial sponge-work which fills the greater part of the heart cavity. In this syncitium numerous large nuclei develop and ultimately migrating to the surface of the sponge-work bud off into the vascular fluid as mother-cells of the red-blood corpuscles. These large nuclei appear in the endocardial sponge-work when the larva is about 28 mm. long. During the succeeding stages the sponge-work increases in size and the nuclei multiply rapidly. In the 30 mm. stage a large number of these hæmoblasts are found attached to the surface of the reticulous tissue, from where they sever their connection and become free megaloblasts in the vascular fluid. At the 35 mm. stage the larva is at first rather opaque and the blood is colourless. When metamorphosis starts a silvery sheen apears on the dorsal surface, and the body becomes opaque and the blood commences to turn red.

A similar condition occurs during the development of the Eel. The Leptocephalus larva is of a glassy transparence. The larva reaches a maximum length of 78 mm., metamorphosis then begins and red corpuscles appear.

In Teleosteans in general the blood originates from the intermediate cell mass during the early embryonic stage, but in Herring the hæmocytopoietic function is confined to the endocardium till the spleen develops.

THE PHYSICAL SOCIETY.

Friday, February 5.

The following papers were read :—

The Collisional Friction Experienced by Vibrating Electrons in Ionised Air. By E. V. APPLETON, F.R.S., and F. W. CHAPMAN, M.Sc.

The variation of the radio-frequency conductivity of ionised air with pressure has been studied experimentally at frequencies of the order of 10^6—. From the measurements of the critical pressure at which such conductivity is a maximum, the magnitude of the collisional frictional forces experienced by vibrating electrons has been estimated.

Surface Heating by Neutralised Positive Rays Before and After Return to Normal State. By M. C. JOHNSON, M.A., D.Sc., Birmingham University.

A nearly parallel beam of positive rays emerges through a cylindrical aperture in a cathode, and enters a space where the vacuum is kept high enough for gas collisions to be negligible. Experiments are carried out to decide whether the impact of neutralised atoms in the beam is able to heat a solid target to the same extent before and after their spontaneous return from excited to normal atomic state. This is done by investigating the disturbance of a bridge balance between two filaments accurately aligned across the beam at different distances along its path. With the aid of control experiments, and after elimination in the bridge of all effects common to the two wires, an excess heating is shown to occur in that filament which receives the larger proportion of atoms in excited states. The variation of this excess heating with the potential driving the discharge is found to be quantitatively in agreement with the variation of concentration of excited atoms at the different distances along the beam : this latter is calculated from Wien's experiments on the exponential decay of excited states along the path of neutralised positive rays.

The Rapid Determination of the Moisture-Content of Seeds. By R. M. DAVIES, M.Sc., University College of Wales, Aberystwyth.

Methods previously available for the determination of the moisture-content of seeds are summarised and discussed. Two new methods are described, the first involving the use of a thermionic oscillator, the second a direct-current galvanometer and a battery. The first method is best suited for use with large-grained seed, whilst the second can be used with all types of seed.

Electrolytic Water-Transport and Ionic Transport Numbers. By H. C. HEPBURN, Ph.D., Birkbeck College.

This paper gives the results of determinations of the electrolytic water-transport per faraday in the case of copper-sulphate solutions of concentrations ranging from normal to 1.8-normal. The parchment-diaphragm method has been employed, and difficulties experienced owing to the effect of diaphragm-polarisation have been surmounted by adopting a special experimental procedure. The electrolytic water-transport per faraday remains constant with increasing concentration of copper sulphate up to normal, as the author has shown in a former paper, but decreases regularly with further increase in concentration. The probable factors contributing to this decrease are considered. The sequence in the values of the electrolytic water-transport per faraday corresponds with that in the values of the slope of the curve connecting the Hittorf transport number with the electrolyte concentration, but the corresponding values are not in numerical agreement according to an expression proposed by Riesenfeld and Reinhold. This discrepancy is investigated by means of a more accurate expression derived by the author. The determinations of the electrolytic water-transport are employed to correct the values of the experimental Hittorf transport number.

The Magnetic Susceptibilities of Some Nickel Compounds. By R. A. FEREDAY, B.Sc., East London College.

The susceptibilities of a number of compounds of nickel in the solid state have been measured at room temperature. The atomic susceptibility of combined nickel is found to remain constant, except in the cases of the anhydrous cyanide and of dioxime compounds. Some of the latter are diamagnetic.

THE SOCIETY OF PUBLIC ANALYSTS.

Wednesday, February 3, 1932.

The following papers were read :—

A New Method for the Determination of Lead in Organic Substances, with Special Reference to Dyestuffs. By N. L. ALLPORT, A.I.C., and G. H. SKRIMSHIRE.

The organic material is destroyed by wet oxidation and the lead is removed by shaking with a chloroform solution of diphenylthiocarbazone, which combines with the lead. Finally the lead is determined colorimetrically as sulphide. The method is applicable in the presence of large amounts of iron, but bismuth interferes with the method, and special procedures are necessary when appreciable amounts of tin, aluminium, nickel or cobalt are present.

Some Analytical Applications of Sodium Hydrosulphide. By B. S. EVANS, M.C., Ph.D., F.I.C.

A rapid and accurate method of separating tin from various other metals the sulphides of which are soluble in alkali cyanide, and which are not precipitated as metals by sodium hydrosulphate under conditions in which tin is quantitatively precipitated, apparently as stannous sulphide.

A Rapid Method of Dissolving Lead Alloys preparatory to the Determination of Tin and Antimony. By B. S. EVANS, M.C., Ph.D., F.I.C.

The method is based on the fact that lead dissolves rapidly and completely in a mixture of perchloric and phosphoric acids, whilst tin and antimony form insoluble compounds, which are apparently of the nature of "metastannic" and "metantimonic" acids.

The Phloroglucinol Method for the Determination of Mechanical Wood Pulp in Paper. By H. B. DUNNICLIFFE, M.A., D.Sc., F.I.C., and H. D. SURI, M.Sc.

The phloroglucinol method of Cross and Bevan was found to be unreliable in India, and the authors have therefore studied the effect of temperature on the results, the relationship between the volume of standard reagent and the weight of paper for quantitative reactions, the time required, and the mechanism of the reaction. In the procedure based on these experiments, anhydrous phloroglucinol was used, and the mixture of reagent and prepared paper is left for 18 hours at 35° C., after which the solution is cooled and filtered and a measured quantity is titrated with formaldehyde solution, as described by Cross and Bevan.

Investigations relating to Milk Standards under the Burma Food and Drugs Act. By E. H. BUNCE, F.I.C.

There are no legal standards for milk in Burma, but in the Government Laboratory a minimum of 3 per cent. of fat and 8.5 per cent. of solids-not-fat is adopted for cows' milk, and a minimum of 5 per cent. for fat and 9.0 per cent. for solids-not-fat for buffalo's milk. The composition of milk from herds and individuals of both animals over a period of eleven months is tabulated. A common fraud is the dilution of buffalo milk with water to imitate cow's milk. This can be detected by the cryoscopic method.

Notices of Books.

Formulaire du Chimiste-Parfumeur et du Savonnier. Par. R. M. Gattefossé. 4th edition. 9ins. × 5¾ins. Pp. 360. Paris: Desforges, Giradot et Cie., 27 & 29, Quai des Grands-Augustins. Copies obtainable from Offices of *La Parfumerie Moderne*, 9, Avenue Jean-Jaurès, Lyon. Price, 50 francs.

M. Gattefossé's *Formulaire* is a well-known and much appreciated work, and this new and completely revised edition is very welcome. It is not a book for the general reader or for the amateur perfumer; but those chemists who are actually engaged in the perfumery industry or the soap trade will find it extremely useful. In spite of its title, it is not, like certain recently-published books on the subject, merely or mainly a collection of recipes. As M. Gattefossé points out, the compounding of fine perfumes is essentially an art. No artist can work to formula. He must express his own individuality. And this is as true in the domain of odours, as in that of musical sounds or of design in line and colour.

Nor is the book a dictionary of raw materials. It is rather a practical guide to the art of perfumery, containing numerous hints of use in the compounding of perfumes, the manufacture of cosmetics and the production of scented soaps.

Some points of special or novel interest include the following: a note on the essential oil of lawang, described as possessing a particularly pleasing spicy odour; the use of amyl-cinnamic aldehyde in modern artificial jasmin compounds; the use of lavender concrete; the possibility of using truffles in perfumery, with details of the preparation of a tincture of the fungus; preparation and presentation of solid perfumes; the use of cholesterol in hair-lotions to retard loss of hair; industrial perfumes and the manufacture of scented insecticides; as well as several other matters which will appeal to chemists interested in perfumery and cosmetics.

The section dealing with soap is of decided value, perhaps of special value to British perfume chemists, in view of the fact that soap-perfumery would seem to be the only branch of the subject which has been at all fully developed industrially in this country.

H. S. R.

Forthcoming Events.

FRIDAY, FEBRUARY 19.

Institution of Chemical Engineers. Hotel Victoria, Northumberland Avenue, W.C.2, at 11 a.m. Tenth Annual Corporate Meeting. Presentation of Medals. 12 noon. "Control of Industry," by the President, W. A. S. Calder. 12.45 p.m. Informal luncheon. 2.15 p.m. "Thermal Insulation," by Dr. E. Griffiths, F.R.S. 7 for 7.30 p.m. Annual Dinner. Tickets 12s. 6d.

Imperial College of Science and Technology. Department of Chemical Technology, at 4 p.m. Special Course of Fifteen Lectures on "High-Pressure Gas Reactions," by Prof. W. A. Bone, F.R.S., and Drs. D. M. Newitt and D. T. A. Townsend. Excluding March 25 and April 15.

Society of Dyers and Colourists. George Hotel, Glasgow, at 7.15 p.m. "Sulphur Dioxide Effects in Theory and Practice," by F. L. Goodall.

West of Scotland Iron and Steel Institute. Royal Technical College, Glasgow, at 7.15 p.m. "Progress in Steel Metallurgy as Regards Resistance to Corrosion," by Dr. W. H. Hatfield.

Society of Dyers and Colourists. *Manchester Section*, at 36, George Street, Manchester, at 7 p.m. "Faults in Mercerised Hosiery," by J. Lomas. Followed by a demonstration of the Blancometer by Messrs. Adam Hilger.

Institution of Mechanical Engineers. Annual General Meeting. Storey's Gate, S.W.1., at 5.30 p.m. "Testing of Materials for Service in High-Temperature Steam Plant," by R. W. Bailey and A. M. Roberts.

Physical Society. Imperial College of Science, South Kensington, S.W.7., at 5 p.m.

Institute of Brewing, *North of England Section.* Midland Hotel, Manchester. "Some Observations on Fuel Costs," by A. McCulloch.

Institute of Fuel. 17, Albert Square, Manchester, at 7 p.m. "Maintenance of Uniformity in Industrial Fuels," by Dr. A. C. Dunningham.

S.C.I. *Edinburgh and East of Scotland Section.* Joint meeting with the local Section of the Institute of Chemistry. Paper by Dr. R. Fraser Thomson.

INSTITUTE OF CHEMISTRY. *Edinburgh and East of Scotland Section.* Joint meeting with the local Section of the S.C.I. (See above).

S.C.I. *Newcastle Section.* "Grinding and Sifting," by Major F. de M. Tubman. "Presence of Lead in the Herbage and Soil of Lands Adjoining Coke Ovens and the Illness and Poisoning of Stock Fed Thereon," by J. T. Dunn and H. C. L. Bloxam.

S.C.I. *South Wales Section.* Joint meeting with the local Section of the Institute of Chemistry. Dormie Cafe, Cardiff, at 7.15 p.m. "Food and Disease," by S. Dixon.

MONDAY, FEBRUARY 22.

THE FACULTY OF SCIENCES.—David Wynter Room, Swedenborg House, Bloomsbury, W.C.1., at 8.15 p.m. "The Beginnings of Analytical Chemistry," by Fredk. A. Filby, M.Sc., F.C.S., F.F.Sc.

INSTITUTE OF CHEMISTRY. *Leeds Area Section.* Joint meeting with the Yorkshire Section of the S.C.I. University, Leeds, at 7.30 p.m. "Recent Applications of Microbiologidal Processes in Pure and Applied Chemistry," by Prof. F. Challenger.

S.C.I. *Yorkshire Section.* Joint meeting with the Leeds Area Section of the Institute of Chemistry. (See above).

TUESDAY, FEBRUARY 23.

MANCHESTER UNIVERSITY CHEMICAL SOCIETY. University, Manchester, at 5 p.m. "Atomic Weights and Isotopes," by Prof. R. Whytlaw-Gray.

LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY. *Chemistry Section.* University College, Leicester, at 7.30 p.m. "Fermentation," by Prof. A. Harden, F.R.S.

WEDNESDAY, FEBRUARY 24.

S.C.I. *Nottingham Section.* Technical College, Derby, at 7.30 p.m. "Cellulose as a Chemical Reagent," by J. M. Preston.

FRIDAY, FEBRUARY 26.

S.C.I. *Newcastle Section.* Joint dinner with the Chemical Society, the N.E. Sections of the Institute of Chemistry and the Institute of Metals, North of England Gas Managers' Association, Newcastle Chemical Industry Club. and the Northern Coke-Oven Managers' Association. Royal Station Hotel, Newcastle, at 7.30 p.m. Tickets 8s.

S.C.I. *Liverpool Section.* University, Liverpool, at 6 p.m. "Anthocyanins," by Prof. R. Robinson, F.R.S.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by permission of the Controller of H.M. Stationery Office and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., price 1/- weekly (annual subscription, £2 10s.).

Latest Patent Applications.

2,782.—Imperial Chemical Industries, Ltd.—Mercapto compounds of anthraquinone series. January 29th.

2,784.—Imperial Chemical Industries, Ltd.—Manufacture of mercaptans of anthraquinone series. January 29th.

2,881.—Koppers Co., of Delaware.—Treatment of chemical compounds. January 30th.

Specifications Published.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

365,618.—Johnson, J. Y. (I. G. Farbenindustrie Akt.-Ges.).—Working-up of oxidation products of hydrocarbons.

365,737.—Still, C. (trading as Still, C. (Firm of)).—*Process for obtaining* ammonia and ammonium sulphate *from gases.*

The Latest Trade Marks

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of His Majesty's Stationery Office.

521,158.—A circular label device illustrating a five-pointed star and a burning candle and. a series of Russian characters.—Acids for use in manufactures, photography, or philosophical research.—Gosudarstwennyi Mylowarennyi Sawod Imeni Mullynur - Wachitowa, Tukajewskaja Karanj, Tartaric Republic, Union of Soviet Socialist Republics. Feb. 3. (By Consent).

THE CHEMICAL NEWS

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THE BEGINNINGS OF ANALYTICAL CHEMISTRY.

By FREDK. A. FILBY, M.Sc., F.C.S., F.F.Sc.*

We are all familiar with that stage in the development of the average boy, when there comes upon him that hereditary, racial, curiosity, summed up as his desire "To know what things are made of". Analytical Chemistry seeks to answer that human, racial curiosity; it seeks to discover the simpler components of a complex body. Yet it would be but half a truth to represent analysis as merely the outcome of a scientific curiosity. Probably the more powerful force throughout has been the response to necessity . . . the solving of some practical need or problem.

The early theoretical ideas of analysis need not long detain us. They were hardly helpful. Aristotle, it is true, put forward the excellent definition of an element, as "that into which other bodies can be resolved . . . but which cannot itself be resolved into anything simpler, or of a different kind." But early science was blind to the true elements and sought for earth, and air, or philosophical mercury and sulphur. These ideas were not useful. Boyle did not believe it possible to analyse bodies into such elements. Boerhaave (*circa* 1732) confesses that he had never attained this end . . . and did not know anyone who had. Joseph Black considered such speculation as "unprofitable," and Lavoisier drew nearer the truth when he regarded lime, magnesia, baryta and alumina as convenient elements. Wiegleb speaks of such substances as the False (though useable) elements, and the others as the True (but unattainable) elements.

At first then, Analysis grew, despite the theoretical background. It grew unconsciously, and, as I have said, out of certain practical needs.

First in this list we must rank the study of minerals. In the words of Sir Edward Thorpe, "The beginnings of the Art of extracting and working metals are lost in the mists of antiquity: the chemistry of metals, indeed, has been said to be almost coeval with mankind." Yet until the 16th century advance was admittedly very slow. Most of the analytical knowledge was of a qualitative character, namely, that an ore contained such and such metals, some ash and perhaps sulphur, or the like. From the

* A Lecture delivered before the Faculty of Sciences (Chemistry Section) at the Swedenborg Hall, London, on the 22nd February.

workings of Hechstetter's Mines in Cumberland, and Agricola's De Re Metallica, it appears that considerable advance was made in Germany in the study of minerals and ores during the early 16th century. Agricola describes and classifies ores (the necessary preliminary to all analysis) and gives full instructions for assaying them. Some of his remarks are curious. The Analyst should close the door of his room lest someone coming in should disturb his train of thought. The Balance upon which the specimen was to be weighed (for Agricola believed in accurate quantitative analysis), must be placed in a cupboard so that draughts may not vitiate the results. The ore must first be broken with a hammer and then ground in a mortar, and if necessary softened by saturating with vinegar. Crucibles were to be covered with mufflers of clay to prevent the entrance of dust. He knew, too, how by use of various fluxes and salts, to separate out copper, silver and gold from an alloy of the three. An interesting method of very ancient analysis which he describes with great care, is the touchstone method for alloys. The stone itself was generally dark schist or jasper, and the idea of its use in assaying is attributed to the Lydians (500 B.C.). Agricola had a set of standard needles made of the two metals in proportions ranging from 23.Ag-1.Au. to 23Au-1.Ag and finally 24 Au. The method was extended to include copper alloys as well, and these could be compared in their marks, with standard needles.

Another process that was really analytical was that of distillation. This goes back to primitive times. Raymond Lully (13th century) is said to have obtained alcohol by distillation and to have dehydrated it with potassium carbonate obtained by calcining cream of tartar. Whether this be true or no the practice certainly dates back to near that time. The earliest English work on distillation is probably Peter Morwyng's translation of Gesner's Evonymus, and this, at its end, has a bibliography of earlier works upon the subject, up to about 1550. Glauber obtained pyrolignious spirit by the destructive distillation of wood, and Boyle distilled Oil of Aniseed 36 times and notes that it did not distil like a homogeneous body. Distillation was tried by the alchemists upon most vegetable substances and even fractional distillation was known, while salt was by such methods extracted from sea water even in Greek times.

During the 17th century we trace the gradual rise of the doctrine of acids and alkalis. Further, the dyers and workers in stained glass, had naturally studied the effects of simple chemicals upon colours, and the results that they obtained were communicated to the Chemists. So it was that Robert Boyle speaks of "Papers drenched with infusions of brazil, logwood, or some convenient dying stuff, and then letting them dry in the air." By dropping the suspected liquor on this paper, he says, "A heedful observer may be assisted to guess what kind of mineral impregnates the liquor, and how much it does so." (From Boyle's Hist. of Mineral Waters.) Further, in his "Experimental History of Colours," he gives an account of Litmase, as he calls it, and describes its colour changes with spirit of salt and potashes. Among other colours of use in chemistry he mentions oaken leaves, rose petals, syrup of violets, turmeric, galls and myrobalan. They serve to decide whether a substance belongs to tht "tribe" of acids or alkalis. Litmus was well known to the French scientist Dominic du Clos, under the name of Tournesol, and to others as Lacmus.

Another important practical need that resulted in the discovery of analytical methods was the detection of poisons. Water that had stood long in exposed leaden tanks, wines that had been sweetened with "Sugar of Lead", vegetables that had been cooked in pewter or copper vessels . . . all these required scientific investigation.

Lead was at first detected by the black colour it gave with liver of sulphur, but the fallacy soon became apparent that the blackness was no necessary proof of the presence of lead. Neumann tested oils for lead with a solution of orpiment, observing that "if it have any saturnine taint, it will appear of an orange red colour, while if pure, of a pale yellowish." The relative insolubility of the chloride and sulphate was known in Neumann's time (1750), and later became recognised as a test.

Copper was recognised, even in Boyle's time by the blue colour with ammonia. A long account of the colours obtainable is given in Boerhaave's *Elements of Chemistry* (Trans. Dallowe, 1735, Vol. II. p. 376). He mentions also that copper would be deposited by iron, a fact which was known to, although not understood by, Agricola,

and doubtless to many before his time, especially alchemists in search of transmutation.

Arsenic, says Black (who commenced lecturing on Chemistry at Glasgow in 1756), is detected in the following way: When heated it gives off a white smoke, and if placed on a very hot plate of iron, it will burn. It is evident from this that the element was well known in Black's time. He goes on to say that it may also be recognised by the fact that it turns copper white, another observation which was extremely ancient, and probably gradually became recognised as a test. He was aware that arsenic combined with sulphur to form realgar and orpiment, and although I cannot find that he used this fact as a test, it certainly was so used by Wiegleb in 1789.

The same writer tells us that Magnesium is detected by giving a white precipitate with caustic alkalis, but it must be remembered at once that in his time magnesium meant an ore or derivative of manganese. This is certain from his description, which is obviously that of manganese dioxide, and from tbe well known fact that Pliny refers to MnO_2 as magnesia. Black goes on to point out that the precipitate is almost white, but darkens later. By fusing on a charcoal block before a blowpipe, it is possible to obtain a bead of the actual metal. This was first performed by J. G. Gahn, in 1774.

While dealing with the knowledge of analysis prior to 1750, we may also mention that Boyle detected silver by its white precipitate with marine acid, and Marggraf had determined with considerable accuracy the amount of silver chloride precipitated by the addition of salt solution to a known weight of a silver solution. Since Boerhaave was aware that marine acid would also precipitate mercury, and later Bergman differentiated between two sorts of mercury compounds, we see that we have complete, the first step in the group analysis.

Dominic du Clos was aware of the use of gall nuts as a test for iron, and early in the 18th century the fact that tannin (tea), gave an inky colour with iron, is said to have been discovered by accident, when a tea party used chalybeate water.

Prussian Blue was discovered in 1710 by Diesbach of Berlin, and investigated by Macquer. From it Bergman prepared "Phlogisticated alkali," afterwards known as prussian alkali, and used as a test for iron. M. Wiegleb gives the prussian alkali as a test for iron (blue), copper (brown), and zinc (white).

Our attention is also drawn in this period to the analysis of mineral wattrs. Boyle was among the earliest writers on this subject, and advises that one should seek to discover "whether anything may be precipitated out of the mineral water by salts or saline liquors; whether they be acid as spirits of salt, of nitre, aqua fortis, etc., or volatile alkalis . . ." We have already seen that it was here that he first made use of indicators, and that other workers produced tests for iron and copper. That Lime gave an insoluble sulphate was known at least in Glauber's time, and used as a test by Boyle. Carbon dioxide, recognised by Van Helmont, had been tested for by means of lime water by Boulduc in 1669, and it was not long before the reverse fact became realised that it could be used as some sort of a test for lime. In 1776 Scheele prepared oxalic acid by oxidising sugar with nitric acid, and this product, known as Acid of Sugar ,became widely used as a test for Lime.

The differences between the various alkalis had been studied by Black for his doctor's degree in 1754 and the fact that Potash and Soda were different was known as far back as Abu Mansur Muwaffak (10th-11th century). The credit of noticing the difference in their flame colourations rests with Marggraf (1757), who discovered the fact by heating their salts on a wire in an alcohol flame. Later workers extended this to the other metals found in mineral waters, noting the red of calcium, the carmine of strontia, and after the discovery of lithia, Stein showed that it could be detected by its sparkling red flame test. To Marggraf, too, belongs tht honour of being the first to make use of the microscope in analysis, when he discovered sugar in the beet, but his example does not seem to have been followed up by others.

Mention has been made of the use of the blowpipe. This instrument, which is but the smaller edition of the bellows or other method of increasing the heat of a fire, had long been known to the mineralogist. It is referred to in the Mem. Acad. del Cimento, 1660, by John Kunkel (1679) and Cramer, in Elementa Artis Docimasticæ, both of whom used it for chemical purposes. Much credit, too, it due to Cronstedt, (See J. Landauer, Die ersten Anfange der Lothrohr

analyse, *Ber.*, 1893, p. 898), and later to Bergman, who discriminated between its inner and outer flames. Lavoisier was the first to apply oxygen to the blowpipe. Gahn, much later, made use of fluxes, as microcosmic salt, or purified carbonate of soda, or borax that had been freed from its water of crystallisation. Besides the heating on charcoal, there was cyanite, used by De Saussure, and later Wollaston introduced platinum spoons. It is to Gahn, or perhaps Wollaston, that we owe the idea of heating little beads of borax on a platinum wire, and impregnating with some substance which will give its characteristic colour to the bead.

Before leaving the latter half of the 18th century we must look at Organic analysis. Here, as we should expect, the development was slow; the substances were mainly extremely complex. The theoretical background, the ideas of a vital force, the view that in the organic world, entirely different laws would operate, all these tended to inhibit progress. Perhaps as important, too, was the fact that, in this realm, it was impossible to verify analysis by synthesis. Herman Boerhaave says ' From a composition of the elements which the Art of Chemistry is capable of reducing bodies to, we can scarce ever again produce the original compound . . . (for example) . . . the analysis of blood and wine, and many other things." Yet something could be, and was, done. There was first the classification of the various animal products into certain groups, and the study of their general properties. Neumann tells us that organic bodies, when analysed gave rise to some or all of the following :— water, earth (*i.e.* ash) gelatinous matters, fat, volatile parts, acids, and parts soluble in spirits of wine. This was really a great step, for it was then easier to follow up by analysing the aqueous solution, in more or less the same manner as for mineral waters, and the ash, as a mineral substance. The parts soluble in spirits of wine could then be examined by crystallising out, or distilling off the alcohol; the fat, too, could be subjected to distillation, as well as the other volatile parts mentioned. Finally, the organic acids were studied, and their properties recorded for future reference.

One of the foremost of Organic Analysts was Carl W. Scheele (1742-1786). He made a study of Prussian Blue and prussian alkali, and although this was not regarded as an organic chemical, yet without this development in our knowledge of the ferrocyanides, and thus of the cyanides, we should have waited longer for the synthesis of urea, that greatest of events in the early history of organic chemistry. Scheele, too, was the discoverer and isolator of uric acid from calculus vesicæ. From Cream of Tartar he obtained tartaric acid, and in the later years of his life he investigated the acids, malic, lactic, citric, tartaric, oxalic mucic, gallic, and pyrogallic, and isolated glycerine from milk sugar.

Neumann and Boerhaave had done a considerable amount towards the beginnings of the chemical study of plants. They had examined these, classified them, and sought to analyse them by means of aqueous and alcoholic extraction, by expression, and distillation, and by fermentation. The resulting products had been then subjected to a like further examination.

So far as Gas Analysis is concerned we must trace its beginnings back to the works of Boyle whose gas laws are essential to the development of quantitative gas analysis, and to Mayow and Hooke, whose studies on combustion gave the first clues as to the nature of the atmosphere. Van Helmont must be included here, as the discoverer of carbon dioxide, the gas sylvestre, and from these we should have to come to the time of Scheele, Priestley, and Cavendish. These workers laid the foundations by discovering how gases could be collected and measured, and by discovering which were explosive, which would support combustion, and which were soluble in water. From the latter case it was but a simple step to test the aqueous solutions for acids or alkalis by means of the usual indicators.

Having brought the story of the beginnings of the subject in general up to the end of the 18th century, I shall devote the remainder of this lecture to a brief summary of the beginnings of each special branch of the subject as we know it to-day.

If faced with a given inorganic specimen, we should probably first perform such dry tests as the flame test, bead test, heating on charcoal, or in a tube . . . tests which, as I have said, we owe to the times before 1790. We might, in addition, perform a

spectroscopic examination ,and this dates back to the work of Kirchhoff and Bunsen. If gases were evolved we should subject them to some such series of tests as that which was finally drawn up by Thenard (1813), *viz.* :— 1. Test with lighted taper, if inflammable, note colour of flame, and smell. 2. Pass into a solution of potassa and test the resulting solution for chlorides (bromides and iodides later). 3. Does it fume in air. 4. Test with litmus paper (Boyle). 5. Turmeric (for ammonia, due to Bergman, though turmeric was known as an indicator even to Boyle). 6. Bleaching effects. 7. Glowing splint (Priestley, Scheele and Lavoisier).

We should then try to get the substance in solution. As Agricola says, we should first break it up with a hammer, then grind it in a mortar, and test its solubility in various acids. Agricola used vinegar, but we should more likely follow Boerhaave or Neumann by treating it with acids, then alkalis, and if these failed, by fusing with alkalis as did Klaproth, one of the most accurate mineralogists that ever lived. Having obtained the solution, we should proceed by some scheme of group analysis. One of the first of these was drawn up by Thenard, the chief differences from the modern procedure being that he used an iron plate to reduce the noble metals, tellurium, copper, lead, bismuth, arsenic, an tin, and tbe precipitation of nickel, zinc, and cobalt, was effected as sulphides. For the acid radical we should use the lime water test of Boulduc, for CO_2, the sugar of lead (lead acetate paper), to test for HS_2, known before 1750, for chlorides we should employ the nitrate of silver as used in Boyle's time, for sulphates, either lead acetate (as in early times) or Barium chloride, which Göttling (1790) describes as Ponderous Earth dissolved in Marine acid. If a nitrate were suspected we should follow Thenard's instructions and treat with hot sulphuric acid and copper.

If, on the other hand, we wished to make an exact quantitative analysis of the substance, we could hardly do better than follow in the footsteps of Klaproth and Berzelius. Klaproth was extremely careful to weigh his mortar before and after grinding a substance, so that he knew how much of it had entered the specimen, and of course he knew previously the composition of his pestle and mortar. Jean Rey, Glauber, Black and Lavoisier were all pioneers in the scientific use of the balance, and were emphatic in their belief (which is now the fundamental principle of analysis) that in a chemical change, the total weight remains unchanged.

We should not expect to resolve our specimen into its ultimate elements, but should accept the principle laid down by Bergman, that each element can be best estimated in some convenient form, such as its insoluble chloride, or carbonate. We should refer to some atomic weight tables in our calculations of the amounts of each element present, and for these we are indebted to Bryan and William Higgins, John Dalton, Wollaston, and Berzelius. Wollaston's table, it may be remembered was intended for the use of analysts. Let oxygen, he said, be taken as 10. Then two volumes of oxygen equal 20. The specific gravities of oxygen and CO_2 are as 20 to 27.54. Therefore C must be 7.54. But CO_2 combines with lime in the ratio 27.54 to 35.46, therefore the equivalent for lime is 35.46, and for calcium 25.46. Water being 11.32, hydrogen was 1.32 and by similar argumeuts the equivalents for many often occurring elements were worked out.

In performing our analysis we should not, as Klaproth, take 100 grams, nor as Berzelius, 5 grams, but more probably as later workers still, 1 or 2 grams. Both Klaproth and Berzelius burned their filter papers, and both are highly to be commended for the fact that it was never their intentions to make the totals add up to 100. It was to the fact that the totals sometimes fell short of 100 that Klaproth discovered zircouia and titania.

We might, however, find it more convenient to perform some form of volumetric analysis. The ideas underlying this may go back as far as Richter (1792), who was concerned chiefly with the weights of sulphuric and other acids which could be neutralised by various bases. It is to Descrozilles and Vauquelin that the credit of using volumes instead, belongs. Their first burette (they called it an Alkalimeter) was simply a graduated jar baving its upper mark O and its lower one, 72. It was fitted with a wooden stand to preserve it in a vertical position, and was graduated by pouring in 72 grams of standard solution,

marking the point, and dividing by 72. The standard solution, or alkalimetric liquor was made from 66° Baume Sulphuric acid, carefully diluted to 1/10th. The alkali to be examined was next weighed out, and 10 grams dissolved in water to make one decilitre of solution. The titrations were carried out in a drinking glass, and when neutralisation was near, a drop was taken out on a match, and tested on a drop of syrup of violets on a plate. Such were the simple beginnings of volumetric analysis. Gay Lussac introduced the pipette, his first one having a capacity of 2½ cc. The idea was soon extended to the volumetric estimation of chlorine in solution, it being titrated against standard indigo solution, and later against silver nitrate or arsenious acid. The burette as we now use it is due to Mohr, permanganate methods to Marguerite, and iodine and sulphurous acid methods to Bunsen.

Finally brief mention must be made of the beginnings of quantitative analysis in the organic realm. Lavoisier had analysed alcohol by burning it with oxygen, and his results were reasonably correct.

Gay Lussac and Thenard mixed the substance with potassium chlorate and made the mixture up into little pellets which were heated in a special apparatus, the gases evolved being collected and analysed. The method lacked heavily in being unable to estimate directly the amount of moisture formed by the combustion. Berzelius, who mixed the substance with oxide of lead, and potassium chlorate and salt, heated the preparation in a tube wrapped with tin foil and iron wire to prevent bulging. The products evolved were passed first into a small bulb, the idea of which was to condense most of the water, then through a calcium chloride tube, and finally to a container filled with mercury, on the surface of which floated a bottle of moist potash, for CO_2. Both Berzelius and Liebig made use of copper oxide, and Gay Lussac thought of the idea of exhausting the apparatus of air before the experiment.

Such are the beginnings of analytical chemistry. Those who are interested in its developments in the early 19th century may find them set out in an M.Sc. dissertation under my name somewhere in the University of London Library. Of such methods as micro-analysis, electrical analysis, X-Ray work, and complex organic precipitants for metals I have not here spoken, deeming them to be outside the scope of this, a purely historical lecture.

The Chemistry of the Conversion of the Algæ into Bitumen and Petroleum and of the Fucosite-Petroleum Cycle

By J. E. HACKFORD, B.Sc., F.I.C.

Member of The Institution of Petroleum Technologists.

(*Concluded from page* 108.)

The Mineral Constituents of Oils and of the Bitumens herein described. — The methods employed in qualitatively examining the mineral constituents of the oils and bitumens described are similar to those employed and described at length in the case of the seaweed. The sands and clays were in the first place extracted with a mixture of nitric and hydrochloric acids,* as recommended by Moore, Parsons and others, in order to reduce the overburden of the large amounts of commonly occurring elements, such as silicon, iron aluminium, calcium, magnesium, etc. Where possible the pure oils and bitumens were ashed at a low temperature and the ashes examined without further treatment. The following tables give the results obtained :

* *Bureau of Mines Bull.*, 70. A Preliminary Report on Uranium, Radium and Vanadium, 1916; and *Bureau of Mines Bull.*, 174. Mineral Technology 12. Extraction and Recovery of Radium, Uranium and Vanadium from Carnotite, 1916.

Experimental.

Section III.

The Conversion of Oil into Bodies Resembling the Fucose-Pentosans.

Crude oils from samples Nos. 12 and 18 were smeared on microscope slides and placed in an air oven at 110°C. for one month. Other slides were prepared in the same way and placed in a glass-stoppered vessel provided with inlet and outlet tubes, through which coal gas could be passed on its way to the air-oven burner. After a period of one month it was found that those samples which were exposed to the atmosphere inside the air oven had become insoluble in chloroform, whilst those which were enveloped in the coal gas atmosphere were—like the original crude oil—still soluble in carbon disulphide and chloroform.

In a second experiment the fuel oil residues of samples Nos. 12 and 18 were prepared by distilling off the gasoline and kerosine fractions up to a temperature of 300°C. These residues were spread upon the slides in a similar manner, and heated in the air oven for one month. Similar slides were placed in the coal-gas atmosphere as above described. It was found that the resultant product was even insoluble in pyridine, and, of course, in carbon disulphide and chloroform, but there was no change in the solubility of the samples enclosed in the coal-gas atmosphere.

In another experiment carried out with the above fuel oil residues the oven temperature was maintained at 110° *F.*, so as

Elements	Sample 5. Oil ex sand by $CHCl_3$ extraction	Sample 12. Oil ex wells.	Sample 4. Elkerite.
Aluminium	4+	a little	much
Antimony	0	0	0
Arsenic	0	3+	0
Barium	+	+	+
Beryllium	0	0	0
Bismuth	0	+	0
Boron	3+	0	3+
Cadmium	0	0	0
Caesium	0	0	0
Calcium	3+	much	much
Chromium	3+	3+	6+
Cobalt	0	0	0
Germanium	0	0	0
Indium	+(?)	0	0
Iron	a little	much	much
Lanthanum	0	0	0
Lead	2+	5+	+
Lithium	0	5+	2+
Magnesium	6+	5+	5+
Manganese	0	2+	2+
Molybdenum	3+	(?)	(?)
Nickel	0	much	2+
Niobium	0	0	0
Potassium	0	(?)	(?)
Rhubidium	+	0	3+
Silicon	4+	4+	much
Silver	0	0	0
Sodium	0 or +	much	much
Strontium	0	2+	+
Thallium	0	0	0
Tin	3+	much	0
Titanium	6+	0	4 +
Vanadium	+	much	2+
Zinc	+	a little	0

Elements	Sample 1 Fucosite scraped off the clay	Sample 2. Fucosite ex sand extr. by HNO_3	Sample 6 McKittrite algarite
Aluminium	much	much	much
Antimony	prob. absent	prob. absent	prob. absent
Arsenic	+	3+	0
Barium	+	4+	3+
Beryllium	0	0	0
Bismuth	0	0	0
Boron	6+	6+	5+
Cadmium	+	0	0
Caesium	0	0	0
Calcium	much	much	a little
Chromium	a little	3+	a little
Cobalt	0	2+(?)	0
Germanium	0	0	0
Indium	0	0	0
Iron	much	much	much
Lanthanum	0	0	0
Lead	+	+	3+
Lithium	4+	4+	4+
Magnesium	a little	much	a little
Manganese	2+	6-	2+
Molybdenum	prob. absent	prob. absent	prob. absent
Nickel	+(?)	2+	6+
Niobium	0	0	0
Potassium	(?)	prob. absent	(?)
Rubidium	2+(?)	(?)	(?)
Silicon	much	4+	much
Silver	0	0	0
Sodium	much	a little	a little
Strontium	+	4+	3+
Thallium	0	0	0
Tin	0	0	+
Titanium	6+	6+	5+
Vanadium	3+	3+	6+
Zinc	0	2+	3+

to be comparable with the atmospheric temperatures obtaining in the Elk Hills. The product became insoluble in pyridine (comp. fucosite) and in chloroform (comp. algarite) after a period of nine months.

In another experiment the bituminous shale-like seep (sample No. 6) was subjected to a similar treatment. McKittrite is largely soluble in chloroform, but after heating for two weeks it became insoluble in chloroform. The chloroform extract of McKittrite, when subjected to similar treatment, became insoluble in pyridine after one month.

Preparation of Bulk Supply.—Fuel oil residues were heated at a temperature of 110° C. on sheet iron plates in a gas oven. Approximately 50 gms. of material were obtained. It was totally insoluble in chloroform, and 11 per cent. was insoluble in pyridine. The ash content was 0.31 per cent., and contained comparatively large quantities of the rarer elements.

Properties of "Pseudo-Fucosite."—The material is a black amorphous powder, when viewed in bulk; in the finely-ground condition it appeared to be brown, while in a thin layer on the microscope slide it appeared a yellowish-red by transmitted light. It is sparingly soluble in water and dilute acids, giving pale yellow solutions, possessing a neutral reaction in aqueous solution. It is soluble in dilute caustic soda solution. It is very sparingly soluble in ethyl and amyl alcohols, and is insoluble in most organic solvents with the exception of pyridine in which it may or may not dissolve

according to the method of preparation, and the time during which it was subjected to the prolonged action of heat and the slow oxidation process which takes place in the air oven. On heating it evolves oil, water, and gases smelling of burnt feathers; it sinters and swells at about 200°C.

After prolonged hydrolysis extending over a period of one week, with dilute sulphuric acid (5 per cent. by wt.) tungstic acid gave a precipitate with the tertiary amines formed during that operation. On the addition of a strong solution (33 per cent.) of caustic soda to the acid liquor, and boiling, the strongly alkaline solution gave off ammonia in very appreciable quantities. tities.

The liquors readily reduced Fehling solution and formed osazones with phenyl hydrazine acetate.

On precipitating the free sulphuric acid with barium carbonate and filtering, the filtrate yielded a syrup upon evaporation. This syrup was sweet, but not very sweet, and in this respect it may be noted that arabinose is one of the least sweet of the sugars or pentoses. The syrup was redissolved in water and boiled with animal charcoal and refiltered. The colour of the concentrated filtrate was light yellow, and it deposited a small quantity of needle-shaped crystals, after standing for a few days. Under the microscope these appeared identical with those of arabinose. The liquors themselves readily gave an osazone, which, after recrystallisation from hot water melted at 156°C. M.P., arabinose osazone, 158-160°C.

A further quantity of 25 gms. of this pseudo-fucosite was hydrolysed for one week with sulphuric acid in a similar manner, and on extraction of the resultant solution with chloroform, 3.2 gms. of a light yellow oil were obtained, similar to that yielded by the seaweed extract.

Conclusions.

Algæ are partially soluble in boiling water, yielding alkaline solutions. These alkaline solutions contain sugars formed by the hydrolysis of the fucosan present in the algæ, and alkaline may be converted into gases by the action of anærobic bacteria.

Both bacterial action and oxidation, however, cause a change in the reaction of the alkaline solution, due to the formation of free sulphuric acid. At this stage the free sulphuric acid becomes the hydrolysing agent, and by its agency the fucosan is converted into sugars and the calcium salts of the ethereal sulphonic esters. The free sulphuric acid decomposes the sugars at low temperatures with the formation of algarite and an unstable variety of polyhydric fatty acids, which easily lose both their acidic radicle and part or whole of their oxygen, ultimately yielding hydrocarbon oils.

The calcium salts of the ethereal sulphonic esters are decomposed by water with the formation of mono-and di-hydric alcohols—free sulphuric acid and calcium sulphate. This continued formation of free sulphuric acid accelerates the hydrolytic process. As the esters disappear the tertiary amines make their appearance, and after this the ammonium salts are formed. These bodies are also unstable and readily yield oil which mixes with the mono- and di-hydric alcohols formed by the decomposition of the calcium sulphonic esters. The mixture of oils thus obtained contains naphthenic acids, organic sulphur and nitrogen compounds, traces of very many of the rarer elements and other decomposition products of the algæ. In fact, the mixture of oils possess the properties of naturally-occurring petroleum oils. The yield of oil and bitumen calculated on the water-soluble fraction of algæ is high, representing a minimum of 10 per cent. of oil and 43 per cent. of bitumen.

As the migration of underground waters is established, then it must be conceded that the soluble fractions of algæ, or the oil-forming substances, can also travel in aqueous solution from place to place. These solutions then decompose at leisure in some convenient geologic trap, whether this be on the original site of the deposition of the algæ, or at some distance therefrom. Upon decomposition such liquors precipitate algarite and calcium sulphate over the path of their travel, and at the same time oil is produced. It may happen that these occurrences are simultaneous ,or it may be that the algarite and calcium sulphate are precipitated first and that the decomposition of the liquors is completed in another site.

In the case of McKittrite the algarite has been precipitated in bulk upon and in a diatomaceous earth, but in other cases it is possible that the algarite may be distributed throughout beds of an argillaceous nature. In the dried and metamorphosed condition such beds would be known as " shale " and the algarite as " Kerogen."

The Bitumens.—It appears that the view held at the present time that bitumen is an evolution product of oil must be modified in the light of the evidence now available. So far bitumen has been considered to have been derived from oil by such processes as condensation, polymerisation and oxidation. We now have evidence that bitumens exist, such as the fucosites and the algarites, which are capable of forming oil by degradation processes.

These processes have been described in detail and it has been shown that tertiary amines, ammonium salts, and sugars are formed as intermediate products, together with furfurol in smaller quantities. The major part of the sugars formed are pentoses, and arabinose predominates. We then have still another form of bitumen in elkerite. This bitumen is made in nature by the slow oxidation of petroleum oil at very moderate temperatures under conditions which exist at the present day at the Elk Hills. This insoluble bitumen—a kerite—is deposited throughout certain sands, having been formed in the sands saturated with oil within living memory. Some of these sands are very acid, containing free sulphuric acid generated by the decomposition of the fucosites present, and this acid is capable of decomposing elkerite reforming the original type of oil.

Elkerite may be considered either as an oxidation product of oil, or as a body from which oil is produced by degradation. It has all the properties of a fucosite, it can be hydrolysed, and yields pentoses as intermediate products, and oil as one of the final products, thus exhibiting a fucosite-oil cycle.

Summary.

It has been shown that :—

(1) Oil and bitumen are products resultant upon the prolonged acid hydrolysis of algæ at low temperatures.

(2) Oil and bitumen can be produced by the *acid hydrolysis* of the decomposition products of algæ, *e.g.*, the sugars and the calcium salts of the ethereal sulphonic esters.

(3) By the acid hydrolysis of algæ a bitumen is produced—algarite—similar in properties to the naturally-occurring bitumen McKittrite.

(4) By the acid hydrolysis of sugar, a pure form of the above algarite is formed—algarose.

(5) Oils and bitumens are not formed by the alkaline hydrolysis of algæ.

(6) Some oils and bitumens contain the same range of metallic salts as algæ.

(7) Naturally-occurring oils and seepages contain the decomposition products of algæ in some instances.

(8) Some oils can be oxidised into fucosite, which upon hydrolysis yield sugars.

GAS FIRED FURNACES.

Notable Automatic Pyrometer Control Gear.

By A Well Known Engineer.

One of the great advantages of gas firing for furnaces in many sections of chemical work is the sensitive and accurate control of the temperature that can be obtained.

In this connection, of great interest are the latest designs of automatic electrically operated pyrometer control gear for gas firing, made by the Foster Instrument Company of Letchworth. The arrangement consists essentially of a panel, having a temperature indicator and an electrical control coupled to the electric light main (A/C or D/C) and a thermoelectric pyrometer tube in the furnace connected to the indicating device. The latter is arranged to cut in or out a comparatively strong actuating current to a control valve on a gas supply pipe according to the temperature, that is the movement of the indicator pointer. Operation is on the "by-pass" principle, with automatic control of a part of the gas only, which is supplied to the burners by two pipes, one of which, known as the "by-pass," is always open to the extent desired by means of a hand operated valve while the other opens or closes according to the temperature conditions in the furnace. The gas arrives at this dual circuit by one main pipe and the two pipe lines then join again into one main before the burners. The by-pass valve is adjusted to pass an amount of gas not quite sufficient to give the desired temperature, say about 50° C. below, and then the automatic valve controlled by the thermo-electric pyrometer in the furnace comes into action and allows the extra

small amount of gas to pass to the burner necessary to give the pre-determined temperature, the furnace temperature constantly tending to climb and being periodically checked by shutting off a small amount of gas. This valve is always in action, increasing or decreasing to a very slight degree the gas supply on the control pipe line, the amount of current to operate the valve and keep the temperature correct being brought into action by the indicator pointer as it is depressed closing a relay circuit, the main supply through the by-pass remaining constant. The indicator is of the "Foster" standard wall type, fixed to the panel, while the electrically operated control gear is below, within a dust proof case, containing a 1/50 h.p. electric motor having oil retaining bearings, driven off the lighting main.

Usually the thermo-couple is of the "Foster" tube type, with the outer sheath itself forming one of the dissimiliar metals, the heated junction of which causes a tiny current to flow in the pyrometer circuit thus actuating the indicator, which essentially is a sensitive and accurate millivolt meter, but with the scale graduated direct as degrees °F or °C. instead of millivolts. One of the chief points is the use of the patent "Resilia" movement for the coil carrying the pointer working on pivots between the poles of a permanent magnet actuated by the electric current from the junction of dissimiliar metals in the pyrometer tube. In general the conical pivots carrying the small coil, with the pointer carried in a recessed jewel bearings, have the jewels at the top and bottom. This gives an extremely robust yet sensitive and flexible arrangement in which the pivots cannot "jump" or move on the bearings and are not affected therefore by the usual principle of "periodic" depression used in automatic control instruments, with the pointer indicating the temperature depressed and released again about 6 times each minute, giving a "tapping" effect.

Important also is that adequate magnetic shielding is given, so essential for accurate results. Further, when the working temperature of the furnace exceeds 600° C. there is included an automatic "broken couple" alarm so that if the thermo-couple should fail under these severe conditions, a bell or other loud sounding alarm immediately comes into operation.

DESULPHURISATION OF CAST IRON.

New Chemical Process.

Manufacturers visiting the British Industries Fair, Birmingham, will see on Stand No. 16.E/2 an example of the part being played by the British chemical industry in improving processes in other trades. This is an exhibit which demonstrates a development of the use of soda ash in the manufacture of iron which is of the first importance to British manufacturers of iron and steel. Briefly, the process consists of adding a quantity of soda ash to the ladle into which the molten lead is poured at different stages in its manufacture. It has been found that the addition of this cheap industrial chemical has the effect of cleaning the iron, especially in reducing the sulphur content. Treatment with soda ash results in a tougher iron at the same time as in a lowering of production costs. A working diagram will show clearly at what stages in the process manufacturers should apply the treatment, while a series of photographs will also illustrate the superior structure of the metal treated with soda ash.

THIRD INTERNATIONAL CONFERENCE ON BITUMINOUS COAL.

Announcement is made of the publication of the Proceedings the Third International Conference on Bituminous Coal, which was held under the auspices of the Carnegie Institute of Technology, Pittsburgh, Pa., U.S.A., in November, 1931.

The proceedings, printed in two volumes of approximately 900 pages each, include all papers and discussions delivered at the four-day meeting. Contributions of scientists from Belgium, France, Germany, Holland, Italy, Japan, Roumania, Spain, Sweden, and U.S.S.R. have been translated into English. Illustrations and graphs have been incorporated in the books.

Among the subjects which were discussed by outstanding experts during the conference and which are included in the two volumes are:— economics of the bituminous coal industry, competition between fuels, low temperature and high temperature carbonisation, coal carbonisation problems, gasification, by-products, hydrogenation and liquefaction, railway and steamship fuel, domestic utilisation of coal, power plant fuel, pulverised fuel,

smoke and dust abatement, preparation of coal, coal cleaning, origin and classification, and stream pollution.

Of the 98 papers included in the proceedings, 39 were contributed by Americans, 22 by British scientists, 20 by German fuel technologists, and seven by French.

The third proceedings are similar to the two sets previously issued. These books are regarded throughout the world as standard reference works on fuel technology.

THE GREASELESS GARAGE.

Garage proprietors, engineers, mechanics and others will be interested in the wonderful new cleaning machines made by Imperial Chemical Industries, Ltd., and exhibited by them on Stand No. 16.E/2 at the British Industries Fair, Birmingham. These vastly improved degreasing plants are of many types, designed for all metal-working trades, from those of aeroplane engines and locomotives down to those of watches and gramophone needles. They all comprise a tank which contains trichlorethylene vapour. All that the mechanic need do is to submerge the dismantled motor or engine part in the vapour. In five to ten minutes the oiliest of parts is rendered completely grease-free and dry, ready for inspection and overhaul.

The fact that trichlorethylene is not inflammable is an additional asset in garages and other places where explosive petrol vapour is always present. In those garages and service stations where the degreasing plants have already had a trial, the very simplicity of the process has already reduced overhead charges considerably and the new models which will be shown for the first time at the British Industries Fair should have a revolutionary effect on the work of the mechanic, who will now be able to spend the whole of his time on the work for which he is trained and for which he is paid, instead of being continually hampered by the grease and dirt with which all motor parts become covered and which in the past have been the ruination of hands, clothing and tempers.

VICKERS PROJECTION MICROSCOPES.

We learn from Messrs. Wild-Barfield Electric Furnaces, Ltd., that they have been appointed distributors for this instrument and that the manufacturing and selling rights are in the hands of Messrs.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

Thursday, February 11.

The following papers were read :—

Artificial Disintegration by α-Particles. II. Fluorine and Aluminium. By J. Chadwick, F.R.S., and J. E. R. Constable.

The protons liberated from fluorine and from aluminium when bombarded by α-particles from polonium have been examined. It has been found that in each case they can be resolved into definite groups and that these groups occur in pairs. The results are explained on the assumption that the α-particles can enter the nucleus through certain resonance levels. To explain the fluorine disintegration it is necessary to suppose that there are two (possibly three) levels, while for aluminium four levels must be assumed. The positions and widths of these resonance levels can be deducted from the experimental results.

The Formation of Superlattices in Alloys of Iron and Aluminium. By A. J. Bradley and A. H. Jay. Communicated by W. L. Bragg, F.R.S.

Alloy structures of iron and aluminium in the range Fe-FeAl are primarily based on a simple body-centred cubic lattice like that of α-iron, but a detailed examination of the annealed and quenched states gave widely-differing results.

Alloys quenched from 600° C. and above showed a random distribution of atoms up to 25 atomic per cent. Al. Between 25 per cent. and 26 per cent. Al there is an abrupt change of structure, and thence up to 50 per cent. Al cube centres differ in composition from cube corners. The intensity measurements show that in quenched alloys with ordered arrangement one set of positions is occupied only by iron atoms, but the other set contains iron and aluminium atoms in varying proportions depending on the alloy composition.

Annealed alloys with less than 18 atomic per cent. Al have a random distribution, and from 40 to 50 per cent. Al they have the FeAl type of structure exactly like the quenched alloys in this range. At intermediate compositions a new type of structure appears, which is of the type Fe_3Al. In the latter the Al atoms lie on a face-

as great as those of the small body-centred cube.

Intensity measurements have been used to determine the process of the building up and decay of the Fe_3Al structure. There is, however, no precise composition at which the Fe_3Al structure can be said to begin or end, and the structure is not completely realised even at the theoretical composition.

A Method of Measuring the Effective Resistance of a Condenser and of a Long Straight Wire. By E. B. Moullin. Communicated by R. V. Southwell, F.R.S.

The resistance of a high-frequency circuit usually exceeds the calculated resistance of the inductance coil and the discrepancy is usually assumed to be due to losses in the tuning condenser. This paper describes a method by which the resistance of the condenser can be separated from that of the whole circuit, and consists in using similar coils with wires of different specific resistance and in plotting the measured resisance of the whole circuit against the calculated resistance of the coil. The result is found to be a straight line which does not pass through the origin, thus thowing that there is a component of resistance which does not depend on the conductivity of the material: the intercept on the resistance axis shows the effective resistance of the condenser at the frenquency in use. The way in which the resistance of a condenser depends on the frequency can be studied by obtaining a family of such lines at different frequencies.

The slope of these lines shows the resistance of the conductors of the coil, and hence their resistance can be compared with the calculated value.

The coils were long, narrow rectangles, and for such the skin effect formula for a long, straight wire is applicable without modification. This formula has been checked for frequencies between three and ten million cycles/sec., and the measured resistance agrees with the calculated value.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

February 8, 1932.

Lord Mildmay of Flete (President) in the chair.

Mr. Fred Smith reported his election as Chairman of the Chemical Section for the year. Before commencing the business of the Committee the Chairman had referred in sympathetic terms to the death of Mr. G. G. Rea, who had been a member of the Committee for a number of years.

The list of samples analysed for members by the Consulting Chemist during the months of December, 1931, and January, 1932, had been submitted to the Committee.

Expeller Cakes. — In his report Dr. Voelcker drew attention again to the frequently unsatisfactory character of "expeller" (or screw-press) feeding cakes, mentioning a case where "expeller undecorticated groundnut cake" had been found to contain 8.61 per cent. of siliceous matter, with rice in quantity, and also having a comparatively large amount of castor oil bean.

In another instance a member of the Society had sent up two samples taken from different portions of a delivery made to him of groundnut cake—this being also of the "expeller" type. He mixed it with flaked maize and sugar-beet pulp, and had beeu using the mixture quite satisfactorily to his cows until, one day, all the cows refused to take their ration. He thereupon sent to Dr. Voelcker samples of the good and the rejected ration. To all appearance the cake in each lot seemed just the same, but, on tasting it, that in the rejected ration was found to have a very bitter taste, and microscopical examination showed that, while the cake in the satisfactory ration was groundnut cake, that in the rejected ration was not groundnut cake at all, but was composed of some foreign meal or seed, the precise nature of which it has not been possible as yet to determine. It was further ascertained that the rejected ration had been made up with cake from a newly-opened bag, and that the cows had been considerably upset by it. The purchaser sent back the whole lot of the remainder to the merchant who supplied it.

Action of Water on Lead.—Soft water, it is well known, if treated with lime, will not materially act upon lead. In the case of such a lime-treated water conveyed for a considerable distance in a lead pipe, it was found that, when flowing through the pipe, there was practically no increase of action, but if the water was allowed to stand in the pipe for any length of time, action on the lead was more pronounced. For that reason it is always well, in such cases, to run off the water that has been standing in the pipes.

THE INSTITUTE OF METALS.

An innovation in the proceedings of the Institute of Metals is being made by the Council in connection with the forthcoming Annual General Meeting of the Institute, to be held in London on March 9 and 10.

Whilst the ordinary business of the Institute and the reading of Papers will occupy the first day and the morning of March 10, the second afternoon's session will be devoted to a General Discussion on "The Testing of Castings."

The Discussion of such a practical question has been planned by the Council in order to interest all sections of the Institute's Membership—those engaged in practical foundry work, engineering users of castings; and testing and investigation experts.

The Discussion will be opened with a short Paper, by Dr. W. Rosenhain, F.R.S., F.Inst.Met., a Past-President of the Institute.

Visitors are invited to take part in the Discussion. Cards of invitation admitting to the Meeting may be obtained on application to the Secretary, Mr. G. Shaw Scott, M.Sc., F.C.I.S., 36, Victoria Street, Westminster, S.W.1., who will also supply forms in connection with membership. Persons elected now will have the privilege of membership, not for the usual twelve months, but for the extended period ending June 30, 1933, and will be in a position to take part in the proceeedings at the March Meeting, at which, in addition to the above-mentioned General Discussion, 14 papers will be presented.

The Annual Dinner will be held at the Trocadero Restaurant on March 9, the principal guest being the Minister of Transport, Mr. P. J. Pybus, C.B.E., M.P.

FACULTY OF SCIENCES.

A lecture read before the above Faculty on January 5th by Mr. W. H. Wakinshaw, M.A., Dip. Ed. (Oxon.) on "The New Economics," has been published in pamphlet form (28 pp.) price 6d., and can be obtained from the *Chemical News* Office, or from the Office of the Secretary, 29/31, New Oxford Street, W.C.1. No one interested in the present-day economic difficulties should be without this booklet.

Notices of Books.

Alcoholic Fermentation. By PROF. ARTHUR HARDEN, D.Sc., F.R.S. Fourth Edition. Pp. viii+243. London: Longmans, Green and Company. 1932. Price 15s.

This new edition of Prof. Harden's monograph on *Alcoholic Fermentation* brings the subject up-to-date in spite of the fact that many discoveries of fundamental significance have been made since the third edition was publisbed. It will be recalled that after a comprehensive historical survey, Prof. Harden proceeds to give an account of the knowledge of fermentation processes since Buchner discovered, at the close of last century, that sugar was fermented by the enzyme, zymase, and that actual living cells were not essential to the process. This discovery not only led to a more complete, albeit still imperfect, knowledge of the mechanism of fermentation but also paved the way for an elucidation of changes undergone by carbohydrates in the process of metabolism both in plants and in animal organisms. Prof. Harden, for instance, has himself made a careful study of the rôle of phosphates and has also contributed to our information concerning the by-products of alcoholic fermentation. Prominent among the non-nitrogenous substances which are found in fermented sugar solutions are fusel oil, succinic acid, glycerol, acetic acid, aldehydes, esters and traces of fatty acids. All these matters are fully discussed in the light of the latest researches and Prof. Harden, in his chapter on the mechanism of fermentation points out that Buchner's "zymase" in reality consists of many enzymes and co-enzymes. Each sugar has a specific zymase and several theories have been advanced to explain these and other phenomena.

The bibliography, already extensive and now comprising 40 pages, has been revised and brought up to include all the important communications since the last edition appeared. The monograph is, therefore, the standard publication on the subject.

Malerische Winkel und Höfe aus dem Alten Pressburg. By CHARLES BENYOVSZKY. Pp. 40+40 plates. Bratislava: S. Steiner. 1932. Price 20 Czechoslovak crowns.

The annual International Danube Fair at Bratislava (known also by its German name,

Pressburg), has introduced the capital of Slovakia to industrialists in Great Britain. Its chemical works, petroleum refineries, explosive factories, wood and chocolate works and other undertakings have recently tended to make it an important city in addition to being a modern inland port. Moreover its new university, named after Komensky (Comenius) the mediæval pedagogue, has made it the centre of Slovak learning.

But it is not with these that Mr. Benyovszky is primarily concerned. He has already written authoritatively on Bratislava in his " Bratislava — Pressburg in Wort und Bild " and " Sagenhaftes aus Alt-Pressburg," and now in his " Picturesque Courts and Corners in old Pressburg—Bratislava " he traces many interesting facts connected with the history of this old Danubian city. No point of general interest has escaped his attention and the forty photo plates illustrate some of the out-of-the-way spots usually overlooked even by those acquainted with Bratislava. One of these refers to an old pharmacy said to have been established at the end of the 14th century. Mr. Benyovszky is to be congratulated upon his latest work which should serve to make the capital of Slovakia better known.

G.D.

Hydrierung der Kohlen, Teere und Mineralöle. By PROF. E. GALLE. Pp. 112 with 16 Illustrations and 28 Tables. Dresden and Leipzig: Theodor Steinkopff. 1932. Price 9 marks.

The hydrogenation of various types of coal, tar and natural mineral oils has become a problem of great industrial importance in this age of motor engines and Prof. Galle's lucid monograph has appeared at an opportune moment. The author refers to the work done, with and without catalysts, up to 1918 and then traces the more rapid development during the last decade. The various experimental conditions of pressure and micro- and macrocatalytic agents are very fully discussed and although the Bergius process comes in for a large share of the present work other methods, even those under reduced pressure are adequately described and some account is given of the hydrogenation products and their separation. The monograph is one of extreme topical interest.

Forthcoming Events.

FRIDAY, FEBRUARY 26.

S.C.I. *Newcastle Section.* Joint Dinner with the Chemical Society, the N.E. Sections of the Institute of Chemistry and the Institute of Metals, North of England Gas Managers' Association, Newcastle Chemical Industry Club. and the Northern Coke-Oven Managers' Association. Royal Station Hotel, Newcastle, at 7.30 p.m. Tickets 8s.

S.C.I. *Liverpool Section.* University, Liverpool, at 6 p.m. " Anthocyanins," by Prof. R. Robinson, F.R.S.

INSTITUTE OF CHEMISTRY. *Liverpool and North Western Section.* Joint meeting with the Liverpool Section of the S.C.I. (See above.)

INSTITUTE OF BREWING. *Scottish Section.* Caledonian Hotel, Edinburgh. Annual Dinner.

OIL AND COLOUR CHEMISTS' ASSOCIATION. College of Technology, Manchester, at 7 p.m. Paper by A. Hancock.

MANCHESTER LITERARY & PHILOSOPHICAL SOCIETY. *Chemistry Section.* 36, George Street, Manchester, at 7 p.m. " Chemistry and Industrial Applications of Asbestos," by R. E. Forbester.

ANDERSONIAN CHEMICAL SOCIETY. Royal Technical College, Glasgow, at 3.15 p.m. " Glasgow's Contribution to Chemical Industry," by Dr. I. V. Hopper.

MONDAY, FEBRUARY 29.

INSTITUTE OF METALS. Official visit to British Industries Fair, Castle Bromwich. Birmingham.

TUESDAY, MARCH 1.

CHEMICAL ENGINEERING GROUP. Joint meeting of several learned Societies. Caxton Hall, Westminster, S.W.1., at 7.45 p.m. " Some Problems Connected with High-Speed Compression-Ignition Engine Development," by C. B. Dicksee.

WEDNESDAY, MARCH 2.

S.C.I. *Montreal Section.* McGill University, Montreal, at 8 p.m. " Epochs in Chemical History," by Dr. W. H. Hatcher.

INSTITUTION OF CIVIL ENGINEERS. Annual Dinner.

SOCIETY OF GLASS TECHNOLOGY. *London Section.* Visit to the Beckton Works of the Gas Light and Coke Company, at 7.30 p.m.

THURSDAY, MARCH 3.

S.C.I. *Bristol Section.* University, Bristol, at 7.30 p.m. Commercial Explosives," by Dr. W. Cullen.

CHEMICAL SOCIETY. *Ordinary Scientific Meeting.* Burlington House, Piccadilly, W.1, at 8 p.m.

INSTITUTE OF METALS. *Birmingham Section.* Chamber of Commerce, Birmingham, at 7 p.m. "Gasses in Metals," by S. L. Archbutt.

MONDAY, MARCH 7.

S.C.I. *London Section.* Joint Meeting with the Food Group. Burlington House, Piccadilly, W.1 at 8 p.m. Discussion on "Science and Food," to be opened by Dr. L. H. Lampitt.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by permission of the Controller of H.M. Stationery Office and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., price 1/- weekly (annual subscription, £2 10s.).

Speciocations Published.

366,002.—Blanc, G. A.—Method of the removal of colloidal silicas from mixed solutions obtained during the treatment of powdered silicates with acids.

366,022.—British Celanese, Ltd., Oxley, H. F., Groombridge, W. H., and Challis, W.—Manufacture of acetic acid.

366,026.—Groves, W. W. (I. G. Farbenindustrie Akt.-Ges. — Manufactures of complex compounds or arsenic acids.

366,417.—Peroxydwerk-siesel Akt.-Ges. — Production of hydrogen peroxide.

366,420.—Mentzel, A. — Manufacture of soda, ammonium chloride, nitrate of soda, and hydrochloric acid.

Abstract Published.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

360,922.—Methane.—Buswell, A. M., 57, Chemistry Building, Urbana, and Boruff, C. S., Chemistry Department, Monmouth College, Monmouth, both in Illinois, U.S.A.

A combustible gas containing methane is produced by submiting fibrous cellulosic materials of the nature of corn stalks, bagasse and the like to the action of anaerobic and/or aerobic bacteria found in sewage sludge or to cultures of the same, the action being terminated when the more readily decompcsed portions of the cellulosic material have been destroyd. The cellulosic material may be given a pretreatment with hot water or with hot dilute acids such as dilute sulphuric acid or lime water. Excessive foaming during the fermentation is prevented by introducing liquid drawn from a lower point in the vat on to the surface of the liquid in the vat.

The Latest Trade Marks

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of His Majesty's Stationery Office.

GASOPAK.

526,220.—Opaque colours included in Class 1, chemical substances for use as opaquing agents for glass and enamel, vitrifiable colours or pigments and enamels (in the nature of paint).—The Firm trading as Vereingte Chemsiche Fabriken Freidl. Heller & Co., 5-9, Sebastian Kohlgasse, Vienna, Austria. February 10.

ROYZINE.

528,041.—Chemical substances for use in pickling metal.—Sir S. W. Royse & Company, Ltd., 20, Albert Square, Manchester. February 10.

TRI-RAD.

528,287.—Chemical substances used in manufactures, photography or philosophical research, and anticorrosives. — Stanco Incorporated, Bayway, State of New Jersey, 100, West Tenth Street, Wilmingston, State of Delaware, and 2, Park Avenue, New York, State of New York, United States of America. February 10.

THE CHEMICAL NEWS

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THE FOOD VALUE OF BEER.

The current issue of the *Journal* of the Institute of Brewing contains an important article by A. Chaston Chapman on the food value of different English and foreign beers. Mr. Chapman prepared this information for presentation before the recent Royal Commission on Licensing by undertaking the analysis of samples of 102 beers obtained exactly as they reached the ordinary consumer. Beer must inevitably contain, in addition to alcohol and water, a considerable amount of carbohydrates (sugars), flavouring matters derived from the malt, various flavouring and tonic constituents from the hops, a little nitrogenous matter and small quantities of mineral salts. From the representative samples he selected, Mr. Chapman found the following percentage results for total solids and alcohol content :

	Total solids	*Average*	*Absolute Alcohol*	*Average*
Mild ales	3.87-6.00 ...	4.84 ...	2.98-4.37 ...	3.38
Bitters & Pale Ales	2.81-4.64 ...	3.78 ...	3.38-4.36 ...	3.92
Stouts & Porters ...	4.75-7.04 ...	5.78 ...	3.10-4.30 ...	3.75
Strong Beers ...	4.65-9.55 ...	6.36 ...	7.00-9.38 ...	8.43
Munich Beers ...	5.55 ...	— ...	3.61 ...	—
Czech Pilsener ...	5.60 ...	— ...	3.54 ...	—

Defining a food as " anything which, when taken into the body, is capable of repairing its waste or of furnishing it with material from which to produce heat or nervous and muscular work," Mr. Chapman points out that carbohydrates and proteins such as are in beers are equally producers of heat and energy, usually expressed scientifically in calories. The distinguished analyst has determined the calorific value of the 102 samples he used for his analyses. It has been shown also that alcohol, in moderate doses, is completely burned in the hody and in estimating the food value of a beer this factor must be included. In excessive doses, alcohol which is not converted into carbon dioxide and water in the body is excreted and its food value is lost.

The average total calories per pint of various beers are as follows :—

Mild ales	244
Bitters and Pale Ales	245
Stouts and Porters	283
Strong Beers	483
Country beers	209-362
Munich Beers	272
Czech Pilsener	270

Finally, reference is made to the mineral salts contained in beer, which, it is pointed out, are frequently of considerable health value, although of course they have no direct food value.

PROBLEMS CONFRONTING THE SPRAYER.

II.—THE VOLUME OF SPRAY PASSING THROUGH NOZZLES OF VARYING DIAMETERS AT VARYING SPRAYING PRESSURES.

By C. W. B. Wright and R. M. Woodman.

In the first communication[1] of this series it was mentioned that, when spraying, the nozzle and pump pressure used are of importance. The present note is a preliminary attempt to arrive at the effects caused by using spray nozzles of varying diameters with varying pump pressures, water being the liquid sprayed in these test trials.

A Drake and Fletcher nozzle, with three interchangeable case-hardened steel discs bored to have outlets 1/16, 3/32 and 1/8 in. *in diameter respectively, was used.* As the depth of the swirl chamber of such a nozzle can be varied, this also having a great effect on the throw and spread of the jet and on the type of droplet subsequently produced, a vernier gauge was attached to the nozzle so that observations could be made at two definite swirl chamber depths, 19/64 and 25/64 in.; these depths represented the *minimum and maximum depths of swirl* chamber possible with easy, successful working.

The nozzle was attached to a horizontal, rigid, rod lance which was fixed at its other extremity to the outlet of a pressure spraying outfit invented and manufactured by C. T. Lack, Esq. The machine had two tanks graduated in 5 gal. each holding 50 gal., either tank being capable of independent use and of being filled whilst working *on* the other. The pump pressures used were 30-300lbs./sq.in., ascending by units of 30; the pressure at any point could be kept steady at a good average, the indicator of the attached gauge varying through about 5lb/sq.in. only.

Known volumes of water were sprayed, the times for delivery being taken by stop watch. Average times thus obtained, cal-

TABLE I.

TIME TO SPRAY 10 GAL. AT DEPTH OF SWIRL CHAMBER OF :

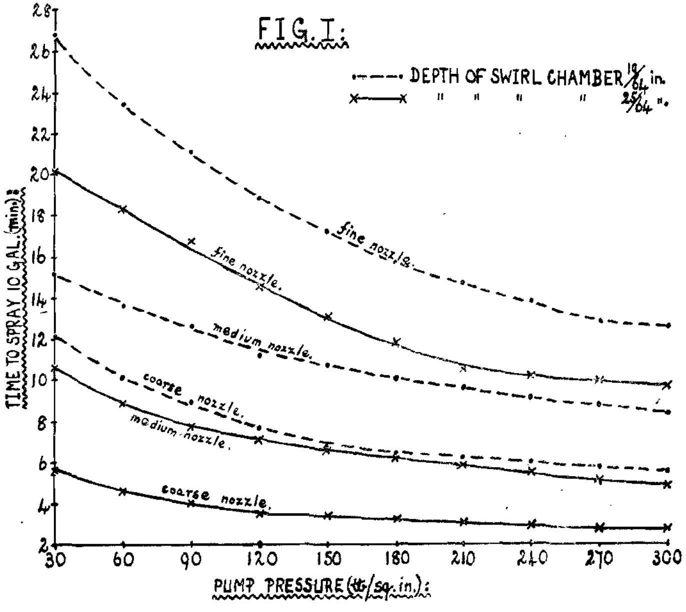
Pump Pressure lbs./sq.in.	19/64in. fine nozzle min.	sec.	medium nozzle min.	sec.	coarse nozzle min.	sec.	25/64in. fine nozzle min.	sec.	medium nozzle min.	sec.	coarse nozzle min.	sec.
30	26	50	15	10	12	5	20	5	10	35	5	35
60	23	30	13	40	10	5	18	20	8	50	4	40
90	21	10	12	35	8	55	16	45	7	45	4	5
120	18	50	11	10	7	40	14	30	7	5	3	30
150	17	20	10	40	6	45	13	5	6	35	3	25
180	15	50	10	0	6	25	11	50	6	10	3	15
210	14	50	9	35	6	15	10	30	5	50	3	5
240	13	50	0	5	6	0	10	10	5	30	2	55
270	12	50	8	50	5	45	10	0	5	10	2	45
300	12	35	8	25	5	30	9	40	4	55	2	45

[1] *Chem. News*, 1932, *144*, page 116.

culated for a unit of 10 gal., and to the nearest 5 sec., are tabulated in Table I and plotted against the corresponding pressures in Fig. I. The temperature of the water during the experiments (July, 1931) varied from 15-20°.

The following general observations were made during the course of the trials. For any given disc, the greater the depth of swirl chamber, the longer and more acute-angled the jet thrown and the coarser the spray; with any given disc and a fixed depth of swirl chamber, the lower the pump pressure, the shorter and coarser the jet.

The table and graphs indicate that the coarser the nozzle or the greater the pump



pressure, the quicker the delivery, as would be expected; with any given nozzle, the deeper the swirl chamber, the less the period of delivery and the less the effect of pump pressure.

The authors thank Chivers and Sons, Limited, of Histon, and C. T. Lack, Esq., of Chas. Lack and Sons, Limited, Cottenham, for the facilities granted and for aid in these experiments.

Horticultural Research Station,
School of Agriculture,
University of Cambridge.

CENTRALISED SLAUGHTERING.*

By ALDERMAN T. McLELLAN, M.R.San.I., F.F.Sc., J.P.

There is a growing volume of expert opinion in favour of concentrating slaughtering. The construction of the modern Abattoir should be considered in all its aspects similar to schemes of town planning, bearing in mind that the slaughter-house should he as near as possible to a railway siding, and associated with the cattle market, not overlooking other important geographical considerations.

The modern Abattoir itself possesses many advantages over small and insanitary slaughterhouses. It secures, and makes for, *the more humane treatment of animals.* The animals intended for slaughter can be taken with little trouble from the Market to the Abattoir. This also enables inspection, both ante-mortem and post-mortem, to be carried out more expeditiously. Further, Central Slaughtering enables all interests to come together in the matter of greater production and efficiency. Proper sanitary and hygienic arrangements are afforded which have an important bearing in directing all the other branches of the industry towards the goal of real economy. Apart from the actual killing and dressing of food animals, experience has taught us that serious attention must be given to the development of by-products. The potential *commercal possibilities of animal by-*products cannot be over-estimated; especially is this the case in regard to medicinal requirements. Furthermore, due regard must be paid to the elimination of waste. Various processes of salvage and waste prevention are now on the Market, and their proper use can only be made possible by becoming part of the Abattoir.

Construction and General Lay-out.

Certain broad principles have to be recognised in the building and general lay-out of the Public Abattoir. In the various Departments suitable equipment and specialised plants have to be provided to meet all requirements, coupled with impervious flooring, and a complete system of drainage throughout. In fact, it is true to say that this new industry has now become a highly specialised branch of engineering. One of the outstanding features of modern meat production is, to approximate very closely to modern industrial practice. The animal, and then the handling of the various meat products, from one stage to another, has to be so arranged in order that the highest standard of efficiency can be secured. There are two methods that may be applied in the constructon of the Abattoir; these may be described as the open-hall and booth systems. The booth system whilst lending itself to more privacy for the users of the slaughterhouse and may afford better facilities for inspection, does not compare favourably with all the other advantages afforded by the Hall system, because the larger Hall space provides for more air space, better light, and less complications in the general lay-out of water supply and mechanical equipment.

General Requirements.

A general outline of what is required to complete the Modern Abattoir may be summarised as follows :—

1. A site which is centrally situated, and may be approved by more than one Local Authority.
2. Railway Sidings near to main lines.
3. General Arrangements.
4. Lairage Accommodation.
5. Killing, dressing and cooling rooms.
6. Pigs, Slaughterhouse, and Lairages.
7. The Refrigerating Layout.
8. Dead-meat Market.
9. Offal-rooms and Tripe-house.
10. Casings Department.
11. Blood-Department.
12. Meat Detention Room, and suitable Laboratory.
13. Suspect Animal Lairs.
14. Hide and Skin Rooms.
15. Boiler-house, heating and lighting system.
16. Shops, offices, dining rooms, and sanitary annex.
17. Manure-bay, to be kept well apart from out-buildings.
18. Allowance made for extensions having regard to the potential possibilities of developments in the By-product industries, especially medicinal products.

Inspection of Meat.

The lack of uniformity of Meat Inspection is a source of financial grievance to the

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* Abstract of a Report prepared for the Faculty of Sciences, and submitted to the Economic Council of the Cabinet, by Alderman McLellan, in his capacity as Technical Adviser to N.U.D.A.W.

butcher, who complains of unfair competition, and is certainly not fair to the consumer. It is true, however, that the Ministry of Health have within recent years given a lead to Local Authorities from time to time to carry out their recommendations in regard to uniformity of Meat Inspection. Little or no headway can be made under the present system.

The Municipal Abattoir offers the only solution to present day difficulties. An Inspector is constantly on the job, and a watchful eye is kept on all Offals, as well as the carcase. Moreover, quite a number of Local Authorities have now employed full-time Veterinary Officers who undertake the complete survey of the whole inspection ante-mortem and post-mortem.

By-Products.

Not so many years ago the By-products derived, after slaughtering operations, were wasted or dumped into trenches and burned, but with the advancement of science American interests set to work and built up collateral industries, and it is in this regard that stress must be laid as to the importance of these industries being encouraged and developed in these islands. From hides (after tanning) we get many kinds of leather goods, too numerous to mention. Fats when cleaned are made into Oleo Oil and Stearin. The oil is used in making Margarine, and the Stearin into certain cooking compounds. Inedible fats are converted into tallow, and ultimately into soap. Selected bones are used for knife handles, and similar articles. Miscellaneous bones are made to yield inedible fats, glue, gelatine, etc., and the residue is ground and made into bone meal to be used for fertilising purposes. Hoofs are steamed and become the raw materials for buttons, also Neatsfoot Oil. Intestines are cleaned and used for sausage coverings (Sheep), musical strings, tennis racket strings, and surgical ligatures; blood for many purposes; pharmaceutical preparations; animal foods for a variety of purposes. Hair is dried and prepared for brushes, mattresses, plasterers mortar, etc. Numerous glands, cow ovaries, and secretions, for a variety of medicines.

The Pancreas is used for insulin treatment. In the Laboratories Gaul or Bile is used for the preparation of cultures for typhoid. Also, for cleaning clothes, and for the manufacture of printers ink. Pituitary substances are useful for growth, and fresh livers are in constant demand for the treatment of Pernicious Anæmia. I know of several cases where recoveries are being made by this means of treatment, and I feel that the utmost consideration should be given in respect to this matter. Calves stomachs can be used for the treatment of the aforesaid complaint when livers are not available. The mesentary, this organ is usually rendered down for dripping. Ox brains when thoroughly treated have been exported to the Continent as articles of food. Tripe (usually first two stomachs of the Ox) are generally used for human food.

The whole question of the treatment and development of medicinal products requires careful thought, and investigation. I think that the possibilities of new industries springing up along the lines indicated is in our own hands providing there is the organisation available for carrying out the schemes.

DYESTUFFS PROGRESS IN GREAT BRITAIN.

Striking Display.

Though it is common knowledge that Great Britain has made much progress as a manufacturer of dyestuffs during recent years, especially during 1931, the advance will be shown in a most striking form by an exhibit which will appear on Stand No. B.71/74 at the British Industries Fair, 1932, at Olympia. This exhibit will show that, during 1931, no less than 200 new products have been produced by the Dyestuffs Group of Imperial Chemical Industries, Ltd.

All types of dyestuffs are represented in this range of new products and in view of the present tendency for faster shades, not only on high-class articles but also on materials of moderate quality, it is encouraging to note that manufacturers are fully alive to the requirements of the moment and that of the 200 new dyestuffs 80 are products which produce shades fully suitable for use in the manufacture of "guaranteed fabrics."

The majority of these fast dyestuffs belong to the same family as Caledon Jade Green, itself an outstanding contribution to the dyestuffs industry, and a product of British research and development.

The dyestuffs exhibit will also show a forecast of colours for Spring, 1932, prepared in conjunction with the British Colour Council.

A NEW CELLULOSE PLASTIC MATERIAL OF GREAT COMMERCIAL POSSIBILITIES.

A new plastic material which is now being manufactured commercially for the first time will be shown at both the London and Birmingham branches of the British Industries Fair.

This is Benzyl Cellulose and is now being put into production by Imperial Chemical Industries. The possibilities of this new plastic are enormous and so far as can be seen there is hardly a single British manufacturing trade to which it will not be potentially of value, owing to its unique chemical and electrical stability, its impermeability to moisture, its non-inflammable nature and the ease with which it is worked.

Although the first mention of cellulose ethers is by Suida (Monstsheft, 1905, *26*, 415) and the methylation of cellulose is described by Denham and Woodhouse (*J.C.S.*, 1913, *104*, 1735), it is only from 1912 onwards that there appears a long list of patents dealing with the preparation of alkyl celluloses and later aralkyl celluloses. The first products described are soluble in water and a methyl cellulose, soluble in cold water and insoluble in hot water, is now made and sold by the I.G. under the name of Colloresin D. Later patents deal with ethers insoluble in water and soluble in organic solvents. Cellulose ethers have not been used so far for many technical processes such as moulding, although they have been manufactured on the Continent for some little time. This has been because of their prohibitive price. Benzyl cellulose is now being manufactured in this country to sell at a price which compares with that of cellulose acetate. The stability of cellulose ethers recommends them to the Plastics Industry and doubtless the next few years will see them extensively used.

Benzyl cellulose is prepared by the action, of caustic soda and benzyl chloride on cellulose. Benzyl alcohol, dibenzyl ether and sodium chloride are the by-products formed. As benzyl cellulose is soluble in these organic by-products the reaction mass is in a rubbery gelatinous form from which the by-products are removed during the purification. Various organic solvents may be used in the purification to extract the benzyl alcohol and dibenzyl ether. The sodium chloride is removed during the water washes. When purified and dried, benzyl cellulose is a cream coloured moulding material which is white when bleached.

The viscosity of the product may be varied either during the process of benzylation or by subsequent treatments. In this way, a range of materials suitable for various technical applications may be prepared. Various degrees of benzylation may be attained, but the technical product, with the most useful range of solubility contains approximately two benzyl groups per $C_6H_{10}O_5$. Benzylation is a progressive reaction and therefore differs from acetylation, where the tri-ester is first prepared and is then partially hydrolysed to produce the acetone-soluble acetate, which is employed for most industrial purposes.

The outstanding property of benzyl cellulose is its stability. It resists the action of alkali up to 20 per cent .concentration, is unattacked by sulphuric acid of accumulator strength (sp. gr. 1.4) and has thus advantages over cellulose acetate. It is thermoplastic and can be heated up to 180°C. without fear of decomposition and being relatively non-inflammable, like the acetate, can be worked at high temperatures without danger. A property which gives its advantages over other cellulose derivatives is its resistance to water. Its hygroscopicity is 0.5—1.0 per cent. compared with 8—9 per cent. in the case of cellulose acetate. Films and articles made from benzyl cellulose are practically impermeable to water. The electrical properties of benzyl cellulose are excellent and since it is unaffectd by ozone there is a wide outlet for it in some parts of the electrical industry, where rubber rapidly perishes.

Dibenzyl cellulose is soluble in aromatic hydrocarbons such as benzol, toluol and xylol, to which 10-20 per cent. of industrial spirits have been added. It swells in acetone and also in toluol, but does not dissolve. It is soluble in acetone-benzene mixtures, ethyl lactate and benzyl alcohol. A range of plasticisers may be used and includes the aromatic ethers of glycerol, such as the ditolyl etber of glycerol, tricresyl and triphenyl phosphate and dibutyl phthalate.

As will be readily appreciated from the foregoing description of the properties of cellulose ethers, the latter may be used as the basis of lacquers, enamels and various coating compositions and dopes; linoleum substitutes, celluloid, safety glass fillings.

and thermoplastic moulding materials and masses; insulating compositions, silk, aeroplane dopes, artificial leather and gramophone records.

MOULDING POWDERS.

The thermoplasticity and stability of benzyl cellulose make it an ideal base from which to prepare moulding powders. Such moulding powders show no signs of decomposition on prolonged storage. Moulders are familiar with the smell of acetic acid which develops in many cellulose acetate moulding materials on storage, indicating the gradual decomposition which is taking place due, possibly, to traces of sulphuric acid, etc., left in the cellulose acetate. Even the action of relatively strong acid or alkali leaves the benzyl cellulose composition unchanged. Marine weathering tests on shipboard show that mouldings from these moulding materials, after months of exposure in the heaviest of seas and extremes of climate remain unaffected.

The thermoplastic properties of benzyl cellulose, which melts at about 180° C. but softens at lower temperatures, endow the moulding materials with exceptional flowing properties. Such moulding materials are therefore ideal for use in injection moulding. They are free from volatile materials, no solvent is used in their manufacture, and the products, therefore, do not warp. Moulding is carried out at temperatures of 120-160°C. For straight moulding a pressure of ½-ton per square inch suffices, while for injection moulding the normal pressures and injection equipments are used. No curing or hardening process is necessary.

Benzyl cellulose moulding materials have been prepared by Imperial Chemical Industries and are now introduced to the moulding industry for the first time.

These moulding materials are produced in a wide range of light colours. These colours do not darken on exposure. Unlike nitrocellulose, benzyl cellulose is unaffected by sunlight. Clear films made from it do not discolour on prolonged exposure. Transparent and translucent effects can be obtained and there is no limit to the variety of designs and colour effects which can be produced by the moulder. The advantages over the limited colours and effects which can be obtained with ebonite or with phenol-formaldehyde resins are therefore obvious. Benzyl cellulose moulding materials do not stain the moulds as the sulphur in the ebonite moulding materials is wont to do, nor do they require any airing time.

There is no scrap, no waste, when using this new moulding material. The scrap is all capable of re-use. There is no need to emphasise nowadays the advantages in speed of moulding and the consequent saving in production costs when using the process of injection moulding.

Perhaps the property which will make these new moulding materials of greater interest to moulders is their resistance to water. At present cellulose acetate is almost exclusively used in injection moulding. Cellulose acetate, however, is not very resistant to moisture. When exposed in the normal atmosphere it takes up 7-9 per cent. of moisture. For certain moulding, acetate materials cannot be used. We are all familiar with the black ebonite part which holds the nib of the fountain pen and which cannot be made from the same material as the remainder of the pen because the cellulose acetate compositions are not resistant to moisture, or ink. Similarly cellulose acetate cannot be used for certain types of bottle stoppers. The scope of injection moulding has therefore been limited until now because of the difficulty in finding a suitable material. It has now been largely expanded by the advent of benzyl cellulose materials. These moulding materials give moulding with much reduced contraction on cooling. It is therefore possible to mould articles which require a high degree of precision.

As has already been indicated, the use of these new moulding materials is not restricted to ornamental materials but extends into the electrical field. Some mention must, therefore, be made of the electrical properties. Special types of moulding materials are made for electrical uses and the electrical resistivity in some of these is as high as 2.7×10^{15} ohms./cm.^{3}. The dielectric strength is of the same order as that of phenol formaldehyde moulding materials. The power loss, however, is much less, being 0.8-1° at wave lengths of 300 metres and so presents an advantage. The breakdown state is 250-300 KV/cm., and they have the great advantage of being entirely impervious to moisture and non-tracking.

From products of purely academic interest, the cellulose ethers have become technical products of considerable value to

the plastics trade generally. The development of moulding materials from benzyl cellulose is one of considerable interest since, in their resistance to water, alkali and acid, these moulding materials are probably unique.

STRUCTURE SYMBOLS OF ORGANIC COMPOUNDS.

It will be recalled that Prof. I. W. D. Hackh published in *The Chemical News*, 1931, *142*, 19, an account of the Structure Symbols he had devised to express concisely and yet clearly the chemical nature of organic compounds, including even the complex derivatives of both aliphatic and aromatic sections of the subject. Prof. Hackh also gave a summary of these symbols in his invaluable *Chemical Dictionary* and now he has published a full account of this system of his, in "Structure Symbols of Organic Compounds," by PROF. INGO W. D. HACKH. Pp. 140. Philadelphia: P. Blakiston's Son & Co.

The book is designed to apply modern views regarding atomic and molecular structure to the study of organic chemistry and it presents the author's simple notation of distinct educational value. In the first chapter the pertinent facts and fundamentals are stated. Then follows an account of the advantages of the new notation which can be mastered within an hour by the average student. The third chapter includes a systematic list of about 1,000 substances with their structure symbols, all of which are readily grasped and can be reproduced by the reader without appreciable effort.

In addition to their compactness the symbols possess the merit that they represent accurately the chemical structural relationships of a given substance, they are uniform and can be used to show cases where electrons are shared by two atoms, polarity, additive properties, association, orientation and micelles. Such a work as Prof. Hackh's has scarcely yet been appreciated and we hope his book will reach a large number of professors, lecturers and others who will be able to make use of his clear and stimulating structure symbols for the organic compounds.

MAGIC RUST REMOVER.

NEW PAINTS AND VARNISHES.

On Stand No. 16.J/2 at British Industries Fair, 1932 (Birmingham), a chemical which has magic properties for the removal of rust from metal articles is one of the exhibits of Nobel Chemical Finishes, Ltd., of Slough. This is the Deoxidine Rust Remover. It is well-known that to obtain a successful finish in the painting or varnishing of any article, it is essential that all dirt, grease, rust and oil, etc., should be removed from the surface before painting. Deoxidine has the properties of dissolving rust. It is brushed on the article which is subsequently washed with warm water and the resulting surface is completely free from rust and ready for immediate painting. Demonstrations of this interesting product will be given on the stand. Where larger metal surfaces are required to be kept free from rust, Mellanoid Bituminous Paint is recommended. This is peculiarly suitable for metal structures such as gasometers, corrugated roofing of factories, interior painting of girders, and in all cases where protection is more important than decoration.

On another Stand, 13.F/1, Nobel Chemical Finishes, Ltd., and the Fredk. Crane Chemical Company are showing an entirely new range of finishes called Dulux. These represent the greatest advance in paint manufacture for many years snce they are not made from the usual gums, resins and oils, which being natural must vary in quality, but from synthetic gums and oils which can be chemically controlled and guaranteed uniform in quality. They combine properties of durability, flexibility, resistance to acids and salt spray, and hardness of film (making for ease of cleaning and maintenance) which formerly could only be found singly in products specially manufactured to meet a particular purpose. Dulux can be applied by brush or spray and air-drying or stoving qualities are available. They are intended for use on articles at present finished in the ordinary air-drying or stoving finishes, such as automatic scales, bedsteads, machinery, washing machines, fire extinguishers, gas stoves, etc. Visitors will also see on the same stand examples of Belco, Necol, Cranco and other well-known finishes, varnishes, lacquers and enamels.

INVESTIGATION OF ATMOSPHERIC POLLUTION.

REPORT ON OBSERVATIONS FOR THE YEAR ENDED, 31ST MARCH, 1931.

Estimates of the amount of tar, soot and other impurities deposited from the air during the twelve months ended 31 March, 1931, at 98 observing stations situated in 42 important towns and cities of Great Britain, and estimates of the amount of impurities suspended in the atmosphere at observing stations in London, Glasgow and three other towns, are contained in the Seventeenth Report on Atmospheric Pollution issuet by the Department of Scientific and Industrial Research. In industrial districts the amount of solid matter deposited or brought down by rain varied from 550 tons per square mile at one point in Lancashire to just over 72 tons at Western Park, Leicester. The average deposit recorded is between 200 and 300 tons per square mile.

At about two-thirds of the observing stations a reduction in the total amount of impurity deposited is recorded. The most remarkable improvement is shown in the deposit of sulphates where 35 stations have a reduction of deposit. This result is the more satisfactory as it is well known that sulphur in the atmosphere plays a considerable part in the damage done to buildings by smoke which in the case of Government buildings alone, Sir Frank Baines once assessed at £120,000 per annum.

The general improvement, however, does not apply to certain London districts. At Ravenscourt Park in West London, for example, the increase in sulphur deposit has been very excessive, amounting to nearly three times the previous average. At Golden Lane near Finsbury Circus the tar deposit has increased nearly 3½ times. No definite explanations are given in the Report for these increases.

As regards impurity suspended in the atmosphere, it seems probable that London may have to put up with black fogs for many years to come. According to the Report, " sufficient smoke is emitted in London during two or three hours of a winter's morning to produce the blackest fog of which we have any experience, provided that it fails to be carried away, and given that the atmospheric conditions are suitable for this accumulation. A reduction in the rate of smoke emission by one-third would probably appear simply as a delay in the formation of the fog, that is, if under previous conditions the smoke density in fog attained its maximum in two hours, under the new conditions it would take three hours. Looking at this matter in another way, it does not appear from the deposit records that there has been any material reduction in pollution during the last ten years, hence it is difficult to account for the general optimistic belief in the reduction of smoke fogs." One remarkable fact about London's atmosphere is the extent to which thick smoke haze appears to be local. The neighbourhood of Charing Cross would seem to be one of the smokiest in London. During the winter months of 1930-31, a thickish smoke haze was recorded by an automatic recorder at the Westminster City Hall on 135 days, while at Westminster Bridge an instrument recorded a similar haziness on 79 days, one at Victoria Street on 63 days, and one at South Kensington on 58 days. At Kew Observatory, on the other hand, only 19 hazy days were recorded. A smoky fog in London appears likely to be at its maximum at 10 a.m., but the smoke haze thickens again between 7 p.m. and 8 p.m.

The amount of smoke haze in London is apparently far worse than in many industrial centres. In the same months the Glasgow Stations recorded on the average 30 hazy days, while Blackburn had 18 days and Stoke-on-Trent 10.

The most remarkable records come from Coventry, which had not one single day in the period under review on which smoke haze was recorded. The atmosphere at Coventry may therefore be taken as unusually pure for a city of that size. The Report quotes the views of the Medical Officer of Health as to the possible causes of this condition as follows :—

" I doubt if any manufacturing town approximating to the size of Coventry can lay claim to a purer atmosphere; and I suggest several reasons for this viz. :—(1) There are no adjoining industrial towns to add pollution—the City is surrounded by open country, no part of which has an altitude sufficient to cause interference with the scavenging action of the wind. (2) Some

* Department of Scientific and Industrial Research. Report on Observations for the Year ended, 31st March, 1931.

of our largest factories are situated on the outskirts of the City in semi-rural surrounds. (3) Our sources of smoke production are unusually limited for a manufacturing town of this size. Electricity is very cheap here and all large factories use it for power purposes ,and gas, which also is cheap, has to a great extent superseded solid fuel in the treatment of metals. (4) We find it unnecessary to employ a special smoke inspector. (5) The prevalence of the use of gas stoves and gas fires for cooking and heating is another contributory factor in the minimising of the smoke from dwelling-houses. I am informed by our Gas Department that there are over 41,000 gas cookers and 14,500 gas fires installed at the present time, and that during the coal stoppage some years ago only 98 persons applied for coal permits on the ground that they had no gas stoves. (6) The comparative population density is low, viz., 13.4 per acre."

In previous reports on Atmospheric Pollution it has been pointed out that no reliable information exists regarding the extent to which pollution in a particular town may be partly due to impurities carried from neighbouring towns. The present Report records the completion of an experiment to obtain definite data as to the distance to which pollution can be carried by wind from an urban area. Norwich was selected as the site of the investigation, because of its isolation from other industrial areas, and because of the number of roads radiating from it in different directions. The results show that the pollution decreases inversely as the distance of the city and was measurable with the apparatus used at a distance of 5-6 miles down wind from the centre of the city. Norwich is about two miles in diameter and assuming the same conditions the Report suggests that pollution from a town or a group of towns 24 miles in diameter would be perceptible at a distance of between 60 and 70 miles. This distance would be greater or less according to whether the air was polluted more or less than that of Norwich, whose air was, in fact, found to be relatively very clean.

The Report records that during the year the development of a simple method for the routine determination of sulphur in the atmosphere has been completed and a description of it issued to co-operating local authorities. The National Physical Laboratory have also completed their work on an instrument for the measurement of daylight which is now being tested by the Atmospheric Pollution Research Committee. The National Physical Laboratory are also carrying out work on the amount of water in fog as opposed to smoke particles. An attempt is also being made to devise means for distinguishing grits emitted by different types of furnaces from one another.

CHEMISTRY AT THE CENTENARY (1931) MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The Presidential Address to the Chemistry Section (B) of last year's British Association Meeting, was delivered by Sir Harold Hartley, who chose as his subject, " Michael Faraday and the Theory of Electrolytic Conduction." It will also be recalled that at the meetings of the Chemistry Section the papers were grouped into four discussions, namely :—

(1) The influence of the medium on the properties of electrolytes.
(2) Vitamin A and the carotinoids.
(3) The chemistry of Vitamin B and related problems.
(4) The structure of simple molecules.

A symposium, the British Fuel Problem, was also a part of the section's proceedings and the recorder of the section, Prof. Gibson, has now arranged these contributions in a permanent publication which puts on record the present position of chemical science in these wide fields. The work is published by Messrs. Heffer, of Cambridge, and comprises xii + 272 pages.

In the first discussion it was pointed out that most of our ideas about electrolytic solutions were based upon experience in water, and this gave a false impression of the simplicity of the problem, since in water, owing to its high dielectric constant and to the chemical protection afforded by the solvation of both ions, all uni-univalent salts exhibit almost ideal behaviour. A survey of non-aqueous solutions reveals at once a much more complex situation in which the chemical nature of the solvent and the affinities of the ions are often the predominant factors. Thus, a purely physical theory, whilst invaluable in explaining the behaviour of an ideal electrolyte, is far from giving a complete impression of even dilute electrolytic solutions, since it leaves

out of account the chemical nature of both the ions and the solvent molecules. By its dielectric constant the solvent determines the magnitude of the inter-ionic forces. By its power of solvation of the ions it exerts a decisive influence on the extent to which they form ionic pairs and undissociated molecules. Finally, by its viscosity the solution determines the mobilities of the ions.

ECONOMIC BIOLOGY.*

Great advances in synthetic chemistry have tended to cause us to overlook our great dependability upon products of animal and vegetable origin and to the changes that have taken place within the last few decades in connection with the manner of their extraction and utilisation.

This work by Dr. Esdaile is therefore a welcome corrective in that it gives us a clear idea of the enormouse extent of mankind's dependance upon the successful cultivation of the most varied types of plant crops and upon the proper breeding and care of animal stock. Actually the present volume is Part II of her Economic Biology, Part I being concerned with harmful and useful animals. A little reflection will convince us that we are indebted to the animal kingdom for such varied products as leather, parchment and vellum; fur; hair and wool; horn, ivory and whalebone; bone and its products; fats, oils and waxes; and milk and milk products. The range of useful and essential products from plants is no less astonishing and varied. It includes a whole host of fibres, the dyes to colour them, oils, gums, rubber, food products, all kinds of beverages and liquors and condiments as well as timber and tree products.

To describe the natural occurrence, isolation and preparation of all these in adequate detail has been the task of the author and it is interesting to trace, on reading through these pages, how public taste has changed and how it is reflected in the supply and demand of mankind's requirements. The books is profusely illustrated with excellent drawings and should appeal to a wide public. Chemists in particular should find it of service since it reminds them of the extent to which their sources of raw material and natural products are associated with biological origins.

G.D.

* *Economic Biology.* By Dr. Phillipa C. Esdaile. Part II. *Animal and Vegetable Products.* Pp. xvi+231. University of London Press, Warwick Lane, E.C. 1931. Price 10s. 6d.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

February 18, 1932.

The following papers were read :—

The Geometry of the Siliceous Skeletons of the Radiolaria. By D'Arcy Thompson, F.R.S.

The figures of equilibrium and minimal area which are assumed by soap-films in Plateau's experiments have proved helpful in explaining the configurations of various cells and simple tissues in plants and animals. Among tbe most curious and anomalous of cell-forms are those of certain Radiolaria—a group represented by minute siliceous skeletons, of which more than two thousand species have been described by naturalists. In some of these the skeleton resembles a minute spiked helmet with three curved lappets or straps below. It is shown that even such an anomalous configuration as this may be precisely imitated or reproduced by an artificial system of liquid films.

The Collision of Slow Electrons with Atoms. I. By H. W. S. Massey and C. B. O. Mohr. Communicated by R. H. Fowler, F.R.S.

The theory of collisions of slow electrons with atoms has been developed in which the zero approximation is not a plane wave but the wave representing the motion of the electron in the static field of the atom concerned. Using this method the elastic scattering of slow electrons in hydrogen and helium is considered in detail, and the effect of electron exchange included in the calculations throughout. It is found that exchange does not become very important until lower voltages than those obtained on Born's theory using the plane wave as first approximation. At lower voltages it is shown that strong interference effects occur between the incident and exchanged elec-

tron waves, giving peculiar angular distributions of the scattered electrons. These effects are exprimentally observed.

A theory valid for the case of large exchange is also given but not worked out in detail.

The Artificial Production of Nuclear γ-Radiation. By H. C. Webster. Communicated by J. Chadwick, F.R.S.

The production of nuclear γ-radiation by bombardment with α-particles has been observed for the elements Li, Be, B, F, Na, Mg, Al. Negative results were obtained with H, C, N, Ni, Cu, Sn. Two methods of measurement were used, Geiger-Müller tube-counters and high-pressure ionisation chambers, and the relative advantages of each are discussed. By measurements of the absorption coefficients in lead, and in some case also in iron, the quantum energies of the radiations could be deduced from the Klein-Nishina formula. The absorption coefficients had to be corrected for obliquity, and for "degraded" radiation entering the measuring vessel. The magnitude of the Tarrant nuclear absorption coefficient had to be estimated by comparison of the absorption coefficients in lead and iron. The deduced quantum energies ranged from about 8 million electron-volts for boron, to 0.5 million for sodium.

The absolute efficiencies of production of the various radiations were determined from the ionisation currents observed, the apparatus being standardised by means of a source of thorium (B+C) of known strength. They range from about 0.5 quanta per million α-particles for magnesium, to about 80 quanta for beryllium. In addition, the way in which the efficiency of production varies with the residual range of the α-particles was investigated. The processes probably responsible for the radiations are discussed: some appear to be due to the capture of an α-particle by a nucleus without proton emission, others are probably due to a secondary process following proton emission, others may arise from inelastic collisions without capture. The relation between the primary γ-radiation of polonium and the "anomalously scattered" radiation investigated by Gray and Tarrant is discused and an attempt made to explain the results of Slater on the production of secondary γ-radiation in tin and lead by radon α-particles.

THE PHYSICAL SOCIETY.

February 19, 1932.

The following papers were read:—

Electrons and Light Quanta. By Sir Ambrose Fleming, F.R.S., Emeritus Professor of Electrical Engineering in the University of London.

The question whether electrons moving with or against a stream of photons are accelerated or retarded by the momentum of the latter is considered. A study based on known physical constants suggests that the magnitude of such an effect should be measurable in strong sunlight and *a fortiori* in the case of X-rays, but an experimental test has yielded negative results. The conclusion is reached that either photons do not exist as defined mass particles during the transmission of light-energy, or else that the apparent area covered by photons in a beam of radiation or by electrons in an electronic current is very small in comparison with the cross-section of the beam or current.

On the Spherical Shell Method of Determining the Thermal Conductivity of a Thermal Insulator. By S. E. Green.

The spherical shell method of determining thermal conductivity has been applied to a thermal insulator in a system of comparatively small dimensions, the outer diameter of each of the shells employed being roughly 10 cm. Sulphur was selected as the material under test, and the spherical shells were cast in a brass mould. The supply of heat to the centre of the system was maintained electrically, a power-supply of 2 watts producing a temperature-drop of approximately 10° C. across the specimen. The range of temperature covered by the experiments was from 5°C. to 85°C. The results obtained are compared with those derived for sulphur by other observers.

The Optics of Photometric Measurements. By T. Smith, M.A., National Physical Laboratory.

The influence of the apertures which limit the light transmitted from the source to the photometer, and of the reflection and transmission coefficients of the specimen and apparatus used, including the source and the photometer themselves, on the quantities determinable from a photometric balance are considered. The way in which the apparatus is set up must take into account the precise information to be

obtained. A general theory is given, which leads to the conclusion that in precise photometry the measurement of the light reflected in both directions, in addition to that transmitted, is necessary when the properties of materials are being determined. A suitable experimental arrangement for making the measurements is described.

Sir Arthur Eddington's Recent Theories. By W. N. Bond, M.A., D.Sc., F.Inst.P., Lecturer in Physics in the University of Reading.

The significance of Sir A. S. Eddington's work on the fine-structure constant $2\pi e^2/hc$, the ratio of masses of proton and electron M_P/m, and on the cosmical constant, is outlined. The experimental verification of his theory of the packing effect and of the rate of recession of spiral nebulae is mentioned. His predictions that $hc/2\pi e^2 = 137$ and $M_P/m = 1847.60$ are considered in detail. The only evidence against these predictions is that given by four recent experiments, which indicate that $e/m = 1.761 \times 10^7$ e.m.u. Reasons are given for believing that this value is too low, and that Eddington's predictions are consistent with experiment. It is unlikely that *both* his predictions require correction terms of the order 1 part in 1847 and it is shown that if $M_P/m = 1847.60$, then

$$hc/2\pi e^2 = (137 - 0.02_7) \pm (0.01_9 \pm 0.0_2).$$

Hence it is shown that the theory of 137 is probably *exactly* correct. Similarly, it is shown that if $hc/2\pi e^2 = 137$, then

$$M_P/m = (1847.60 - 0.5_9) \pm (0.5_7 \pm 0.0_5),$$

and thus Eddington's prediction for M_P/m might be too great by as much as unity. (These final calculations do not depend on any experimental determinations of e/m.) Consequences of the theories are mentioned. The value of the electronic charge is about $(4.777_5 \pm 0.001) \times 10^{-10}$ e.s.u., differing from the Millikan-Birge estimate by about as much as might be expected when regard is had to the probable error of the latter.

Some Principles Governing the Design of Kerr Cells. By W. D. Wright, Ph.D., A.R.C.S., D.I.C.

The paper describes some principles that were employed in designing a Kerr cell for use in a television system. The volts/intensity characteristic of the cell is developed and the theory is extended to apply to the case when an optical bias is used. The chromatic effects obtained with high potentials are discussed and finally the treatment of the cell as an integral part of an optical system is given. It is shown that from this aspect the most efficient form of cell is one using shaped plates. The frequency-response is briefly discussed.

The Forces Acting on Drops in an Electric Field. By G. D. West, D.Sc., F.Inst.P.

If a horizontal electric field be established while a drop of electrolyte is falling in distilled water, the drop rapidly spreads out into a filament parallel to the lines of force. An explanation of this phenomenon is given on the basis of the charge at the boundary between conductors that necessarily accompanies the transport of electricity. Experiments with dielectrics and with drops that contract instead of expanding are described, and the paper is illustrated with photographs.

Notices of Books.

The Law of Patents for Chemists. By Joseph Rossman, Ph.D., LL.B., B.S. Chem.Eng. Patent Examiner U.S. Patent Office. Pp. ix+304. The Inventors Publishing Co., Washington, D.C., U.S.A. Price 3.50 dollars.

This book is of course, written essentially for American Chemists, but, notwithstanding the difference in the construction and application of U.S. Patent Laws, the book will make sound and instructive reading for chemists of other countries. The chapters in the book devoted to fact, and not to law, will find universal application. Dr. Rossman appears to have presented the first book, in non-technical language, to give a comprehensive discussion of chemical patents for all chemists, etc., as well as for technical school students. Here presented is a wealth of information which is of inestimable value to those concerned with the commercial aspects of the chemical industry, and with the development of that industry, executives are compelled to give closer consideration to patent matters affecting their work.

The book tells the chemist just what to do when he make an invention, then the various steps leading up to the granting of the patent; and what is more important, how to dispose of the commercial rights and to enforce them.

A few of the helpful features are: a glossary which clearly explains patent law terms; a reproduction of a few typical chemical patents; an illustrative example of a complete chemical patent application;

citations for important chemical suits; and information on how to search patent literature and keep up to date with recent patents.

The author is an expert in his subject, being Examiner of Chemical inventions in the U.S. Patent Office, during which time he has passed thousands of patent applications, thus obtaining an intimate knowledge of American Patent Law, which he ably crystalises for the chemical industry in this book. He is a member of the Bar of the U.S. Supreme Court, a graduate chemical engineer and Editor of the *Journal of the Patent Office Society*, a publication devoted to patent law.

This book is worthy of the attention of chemists and industrialists of all countries.

Epilatoires, Exfoliants, Détatouants. By A. CHAPLET. Second Edition. 8½ ins. x 5¼ ins. Pp. 79. Lyons: "La Parfumerie Moderne," 9, Avenue Jean-Jaurès. Price 12 francs.

This new edition of M. Chaplet's informative little work, which has been completely revised and considerably augmented, comes at an opportune moment. Very great interest is now being taken in the composition of depilatories. By means of a carefully planned advertisiug campaign, manufacturers have persuaded the bulk of the women in this country that it is little short of a social crime to appear in a sleeveless dress without first removing the axillary hair. This must mildly amuse many of their continental sisters, who are well aware of the value of their axillary hair, well-cared for and judiciously displayed, in heightening their sex appeal.

Moreover, there is a more legitimate demand for depilatories for removing abnormal growths of hair, and for medical purposes in the treatment of certain diseases of the scalp and its hair.

M. Chaplet has gone into the subject very thoroughly, and, in addition to some interesting historical notes and curious information concerning the practice of depilation by backward races, he deals fully with the chemical composition of depilatories and their effects. The most useful appear to be preparations of various sulphides, of which the author has found sodium mono-sulphide to be the most effective.

The book, which is indexed, also contains chapters dealing with preparations used for peeling the skin, and with those used for removing tattoo marks, many formulæ and curious items of information from various sources being collected together.

The book is one which should be found in the library of every cosmetic chemist and is likely to interest an even wider circle of readers.

H. S. R.

IMPORTANT GERMAN TECHNICAL BOOKS.

Die oxydativen Gärungen. By DR. K. BERNHAUER. Pp. viii + 196. Berlin: Julius Springer. 1932. Price 16 marks 80 pf.

So much biochemical work has been carried out during the past decade or so that it is difficult even for the specialist biochemist to keep abreast of all the developments. Dr. Bernhauer's valuable book gives a detailed survey of the chemistry and technology of the processes in which oxidative ferments contained in the lower plant organisms (bacteria and fungi) play an important role.

In this treatise the author describes the biology and morphology of the oxidative moulds (aspergillæ and mucors) and bacteria and then discusses the simpler oxidation processes resulting in the formation of monocarboxylic acids. These are numerous enough since they include the initial products from numerous sugars as well as the Kojic acid bodies.

Secondary oxidation processes lead to a variety of C_3-compounds and numerous plant acids with two or more carboxyl groups. The application of these biochemical decompositions has become very wide and enters into a host of organic processes of interest to the technical chemist as well as the pure researcher. This detailed summary of the subject should be very welcome at the present time.

Die Fabrikation der Fettsauren. By DR. E. BÖHM. Pp. xiv + 354, with 114 illustrations and 46 tables. Stuttgart: Wissenschaftliche Verlagsgesellschaft m.b.H. 1932. Price 33 marks.

Dr. Böhm's technological monograph on the manufacture of the fatty acids comprises Vol. 13 of Prof. Bauer's series on the Chemistry of Fats and we wish it a wide success, for it covers a field very largely neglected in books on industrial and applied chemistry, even those purporting to deal exhaustively with soap manufacture.

The author traces the development of our

knowledge of the fatty acids from the discoveries of chevreul down to the latest methods of saponification and hydrolysis and use of enzymes. He gives in great detail the works practice and the successful patented methods which are followed or which had a vogue until superseded by further research. The distillation, "hardening," and working up of technical products to give pure compounds, emulsions and various commercial products, are also discussed together with the usual methods of analytical control. The book is intended primarily for the specialist and practical man, but it should appeal equally to those concerned with any branch of applied chemistry and also to organic chemists generally. The printing, setting out of tables and insets and the illustrations leave nothing to be desired.

Forthcoming Events.

FRIDAY, MARCH 4.

S.C.I. *Manchester Section.* Joint meeting with the Manchester Section of the Oil and Colour Chemists' Association. College of Technology, Manchester, at 7 p.m. "Synthetic Resins with Special Reference to the Application in the Paint and Varnish Industry," by E. A. Beavan and Dr. F. J. Siddle.

OIL AND COLOUR CHEMISTS' ASSOCIATION. *Manchester Section.* Joint meeting with the local Section of the S.C.I. (See above).

SOCIETY OF PUBLIC ANALYSTS. Burlington House, Piccadilly, W.1., at 3 p.m. Annual General Meeting.

PHYSICAL SOCIETY. Imperial College of Science, South Kensington, at 5 p.m.

ROYAL INSTITUTION. 21, Albemarle Street, W.1., at 9 p.m. "Michael Faraday and Electro-Chemistry," by Brig.-Gen. Sir Harold Hartley, F.R.S.

SATURDAY, MARCH 5.

BRITISH ASSOCIATION OF CHEMISTS. London Section. Annual Dinner. Broad Street Station Restaurant, E.C.2.

MONDAY, MARCH 7.

S.C.I. *London Section.* Joint Meeting with the Food Group. Burlington House, Piccadilly, W.1., at 8 p.m. Discussion on "Science and Food," to be opened by Dr. L. H. Lampitt.

TUESDAY, MARCH 8.

MANCHESTER UNIVERSITY CHEMICAL SOCIETY. University, Manchester, at 5 p.m. "Some Recent Developments in the Chemistry of *iso*-Pentane Derivatives," by Prof. J. L. Simonsen.

INSTITUTE OF METALS. Swansea Section. Y.M.C.A., Swansea, at 6 15 p.m. "Metallography in Industry," by R. Griffiths. Annual General Meeting.

INSTITUTION OF PETROLEUM TECHNOLOGISTS. Annual General Meeting. Royal Society of Arts, John Street, Adelphi, W.C.2, at 5.30 p.m.

WEDNESDAY, MARCH 9.

ROYAL PHILOSIPHICAL SOCIETY OF GLASGOW. 207, Bath Street, Glasgow, at 8 p.m. "Early Chemistry of Gold," by Dr. A. Kent.

WEDNESDAY, MARCH 9 AND THURSDAY, MARCH 10.

INSTITUTE OF METALS. Annual General Meeting. Institution of Mechanical Engineers, Storey's Gate, S.W.1. 10 a.m.-12.30 p.m. General Meeting. President will read his Presidential Address. 2 p.m.-4 p.m. Papers will be presented and discussed. 7 for 7.15 p.m. Annual Dinner and Dance. Trocadero Restaurant, Piccadilly Circus, W.1. Tickets 15s. MARCH 10.—10 a.m.-1 p.m. Papers will be presented and discussed. 2-4 p.m. Papers will be presented and discussed. List of papers to be presented are: "Magnesium Alloy Protection by Selenium and Other Coating Processes," by Bengough and Whitby. "Influence of Temperature on the Elastic Behaviour of Various Wrought Light Metal Alloys," by Bollenrath. "Some Bronze Specimens from the Royal Graves at Ur," by Elam. "Relative Corrodibilities of Ferrous and Non-Ferrous Metals and alloys. Part III.—Final Report. The Results of Three Years' Exposure at Southampton Docks," by Friend. "Age-hardening of Some Aluminium Alloys of High Purity," by Gapler and Preston. "Behaviour of Single Crystals of Bismuth subjected to Alternating Torsional Stresses," by Gough and Cox. "Thermal Conductivity of Some Non-Ferrous Alloys," by Hanson. "Properties of Copper in Relation to Low Stresses (The Effect of Gold-Work, Heat-Treatment and Composition).

Part I. Tensile and Compression Tests under Short-Time Loading," by Hudson and McKeown. "Observations on the Pressure of Fluidity of Annealed Metals," by O'Neill and Greenwood. "Solubility of Aluminium in Magnesium in the Solid State at Different Temperatures," by Saldau and Zamotorin. "Note on the Interaction of Aluminium and Water Vapour," by Seligman and Williams. "Intercrystalline Corrosion of Duralumin," by Sidery, Lewis and Sutton "Properties of Copper in Relation to Low Stresses (The Effect of Cold-Work, Heat-Treatment and Composition). Part II. Creep Tests at 300° C. and 350° C. of Arsenical Copper and Silver-Arsenical Copper," by Tapsell and Johnson. "The 'Fogging' of Nickel," by Vernon.

THURSDAY, MARCH 10.

S.C.I. NOTTINGHAM SECTION. Joint meeting with the Institute of Fuel. University College, Nottingham, at 7.30 p.m. "Economics of High Temperaure Carbonisation," by Dr. E. W. Smith.

INSTITUTE OF CHEMISTRY. *Manchester and District Section.* College of Technology, Manchester, at 7 p.m. Annual General Meeting. "Mechanism of Chemical Change," by Dr. T. M. Lowry, F.R.S.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by permission of the Controller of H.M. Stationery Office and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., price 1/- weekly (annual subscription, £2 10s.).

Latest Patent Applications.

3,954.—Akt.-Ges, Brown, Boveri, et Cie.—Splitting up of salts. February 10.

4,028.—Broadhurst, H. M., and Imperial Chemical Industries, Ltd.—Treatment of caustic soda solutions. February 10.

4,384.—I. G. Farbenindustrie Akt.-Ges., and Johnson, J. Y. (I. G. Farbenindustrie Akt.-Ges.). — Improving sodium nitrate for being stored, etc. February 18.

3,822.—Phillips Petroleum Co.—Treating hydro-carbons. February 9.

3,804.—Stephen, W. E., and Thomson R. F.—Production of derivatives of phthalic acids. February 9.

Specifications Published.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

366,762.—Johnson, J. Y. (I. G. Farbenindustrie Akt.-Ges.)—Carrying out chemical processes at elevated temperatures.

The Latest Trade Marks.

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of His Majesty's Stationery Office.

OCE.

525,334.—Photographic chemicals, plates and films (sensitised).—Naamlooze Vennootschap Chemische Fabriek L. Van der Grinten, 26, Villapark, Venlo, Province of Limburg, Kingdom of the Netherlands. February 17.

MALTHOID.

528,312.—Chemical substances used in manufactures photography, or philosophical research, and anti-corrosives. — The Paraffine Companies, Inc., 475, Brannan Street, San Francisco, California, United States of America. February 17. (Associated.)

Then entry on the Register of No. 287,697 (1510) will be cancelled if and before this Mark is registered.

ERINOPOL.

528,381.—Chemical substances used in manufactures, photography, or philosophical research and anti-corrosives.—Erinoid Limited, 58, Coleman Street, London, E.C.2. February 17.

THE CHEMICAL NEWS

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ON THE DRYING OF SOME OIL VARNISHES

By PROFESSOR C. K. KRAUZ and F. J. FISCHMANN.

Continuing the investigations of one of us with Mr. V. F. Hrach* on drying of oil varnishes we examined systematically mixtures of linseed oil with some resins, *i.e.*, crude and purified colophony, dammar, shellac and amber. The varnishes were prepared by mixing equal parts of oil and pulverised resin with an addition of weighed off quantities of metallic oxides as driers and by heating the mixtures for a certain time to a temperature strictly limited. As driers the following were examined: lead monoxide (PbO), dioxide (PbO_2) and minium (Pb_3O_4), cobaltous and cobaltic oxides (CoO and Co_2O_3), ferrous and ferric oxides (FeO and Fe_2O_3), and manganic oxide (Mn_2O_3). The cooled mixtures were diluted in all cases with the same amount, *i.e.*, 40 per cent. turpentine oil, let stand for 24 hours, and then analysed. For the examining of chemical changes occurring in varnishes thus prepared, acid, saponification and iodine numbers of the varnishes and of the raw materials were determined. From the amounts of the components applied for the mixtures given theoretical values were calculated and compared with numbers obtained by analytical determinations. As a criterion for judging the quality of the varnishes prepared, their rapidity of drying was used, and the procedure of experiment was exactly the same as in the Krauz and Hrach's work mentioned above. At first, by heating the oil-resin mixtures with 1 per cent. of metallic oxide for 1 hour to a temperature strictly limited, the optimal temperature was determined. By the next series of experiments, whereby the quantities of driers added were changed, the optimal additions of driers were pointed out, and in heating the same mixture for the optimal time to the optimal temperature with the optimal amounts of driers the final optimum was found.

The total amount of all experiments carried out was 369, and so it is not possible to give here all results obtained and one was obliged to confine them only in some diagrams and tables.

* Krauz and Hrach: *On Drying of some Dammar Oil Varnishes*, Chemical News, 1928, 257.

Table I.

Drier	Optimal values	Varnishes from Crude Colophony	Purified Colophony	Dammar Resin
PbO	Drier %	3	3	4
	°C	250	250	240
	Heated hrs.	1	2	2
	Dry in hrs.	81.0	98.3	32.5
PbO_2	Drier %	3	4	4
	°C	260	250	260
	Heated hrs.	½	1	1
	Dry in hrs.	38.3	20.0	6.5
Pb_3O_4	Drier %	4	4	4
	°C	190	180	175
	Heated hrs.	2	3	2
	Dry in hrs.	38.3	22.0	10.1
CoO	Drier %	2	2	3
	°C	270	260	270
	Heated hrs.	½	½	1
	Dry in hrs.	3.6	2.5	1
Co_2O_3	Drier %	2	2	1
	°C	200	190	190
	Heated hrs.	½	1	2
	Dry in hrs.	7.0	3.3	9.1
FeO	Drier %	2	2	1
	°C	290	280	300
	Heated hrs.	1	1	½
	Dry in hrs.	60.8	17.5	24.7
Fe_2O_3	Drier %	1	2	1
	°C	270	220	290
	Heated hrs.	1	1	1
	Dry in hrs.	50.0	14.5	10.4
Mn_2O_3	Drier %	2	2	1
	°C	220	220	230
	Heated hrs.	2	1	2
	Dry in hrs.	13.3	13.3	6.9

As in the case of the experiments with different drying oils, also here, the most fluctuating values are the rapidities of drying. They are fluctuating in limits from 72 minutes to 5 days (118 hours) and depend not only on the kind and nature of the *resin applied, but also on the degree of* temperature and its time of action, and on the kind and quantity of the drier added.

The same phenomenon as in the case of varnishes from different oils, *i.e.*, the consistency of the varnishes prepared was observed: The varnishes formed are regularly the thinner, the higher the temperature applied, whereby, of course, a remarkable influence of the kind of driers could be observed, as for instance, Co_2O_3 always produced the thinnest varnishes, while CoO, under the same conditions, gave usually the thickest mixtures of all.

The results found for varnishes from different oils, *i.e.*, that the same kind of drier requires regularly the same or very near optimal temperature, was observed also in the case of varnishes from different resins, as it may be seen from the following table, where the optimum of dammar varnish with CoO-drier, *i.e.*, 72 minutes was taken = 1 and all other times were recalculated to one decimal place. (Table I.)

The further value deserving to be mentioned is the iodine value. By the foregoing work on varnishes from different oils it was proved that the supposition that oils with higher iodine numbers are able to give varnishes faster drying than that with lower ones, can be only approximately applied. Similar conditions—as far as is generally possible to judge on the basis of experiments with three resins only—were also observed in the case of the different resins:

Resins	Crude Colophony	Purified Colophony	Dammar resin
Iodine values of the resins ...	112.22	132.90	115.5
Average drying of varnishes in hours	36.5	23.0	12.6

As may be seen from Table II, the *iodine values fluctuate irregularly.* All these irregularities only prove the contrary of the opinion concerning any regular connection of iodine value with the drying of oil varnishes.

Not much better is the regularity of the acid values observed which decrease in the majority of cases of both colophonies and rather increase in dammar varnishes. Quite similar is the fact of decreasing of the saponification values.

Very prominent and regular is the influence of the temperature upon the rapidity of drying. As may be seen from the 1st table, the same drier requires the same or at least a vey near optimal temperature of heating also for different resins applied.

Also the optimal times of heating (to optimal temperature) which fluctuate in an interval of ½—2 hours, can be expressed in

Table II.

Varnishes from	Values	Original mixture	PbO	PbO_2	Pb_3O_4	CoO	Co_2O_3	FeO	Fe_2O_3	Mn_2O_3
Crude Colophony	acid	48.88	88.78	87.88	41.89	84.70	45.48	81.55	40.88	40.56
	saponif.	102.08	81.67	79.96	87.62	82.85	105.40	87.16	96.68	84.86
	iodine	248.77	214.27	214.46	217.96	203.28	182.00	196.68	189.68	178.88
Purified Colophony	acid	50.82	41.54	42.11	42.59	89.80	42.04	40.49	40.99	88.88
	saponif.	115.03	77.04	77.01	78.70	80.64	90.78	81.84	88.61	60.72
	iodine	250.80	223.63	211.79	108.97	232.78	205.40	208.28	227.70	212.91
Dammar	acid	8.01	10.68	7.30	8.63	9.20	7.55	9.96	7.20	5.58
	saponif.	70.58	52.40	49.97	85.54	64.08	65.86	52.82	41.70	48.08
	iodine	244.90	228.86	281.30	248.47	228.66	227.05	228.22	245.93	250.12

the rule : a higher termal optimum corresponds to a shorter optimum of time, as the average temperature calculated from all ½ hour heatings is 258° C. while the same value *obtained from 1 hour heatings* reaches only 253° C. and from 2 hours even only 218.5° C. Besides, there can be observed the rule that the same drier applied seems to require the same optimum of time, as, for instance, PbO and Pb_3O_4 2 hours, PbO_2, FeO and Fe_2O_3 about 1 hour and CoO ½ hour, etc.

The fact that the rapidity of drying by the kind of drier is considerably altered may be seen very easily from the 1st table. The best drier for all kinds of resins was found in CoO. Co_2O_3 is very good for the colophonies while for the dammar resin the influence of PbO_2 and Mn_2O_3 is better. The worst drier in all cases is PbO. Certainly interesting is the fact proved that also FeO and Fe_2O_3 are able to be very good driers. It may be said in general that every kind of resin requires a certain kind of drier.

An important factor established is also the *influence* of the quantity of driers added. As in the case of varnishes from different oils, the different resins require the highest addition of all oxides of lead, *i.e.*, 3—4 per cent., CoO needs only 2—3 per cent. and all other oxides are sufficient in an amount of 1—2 per cent.

Having fixed the principal conditions of the forming of varnishes from different drying oils and natural resins, the authors are studying at present analogous questions of preparing oil varnishes from artificial resins and will report upon them in due course.

Institute of Organic Technology,
Technical University of Prague,
Czechoslovakia.

OBITUARY.

We regret to report the death of Mr. Werner Stauffacher, Chairman of the Board of The Sandoz Chemical Company, Ltd., England, following a motor accident at Basle, Switzerland.

Mr. Stauffacher was Managing Director of The Sandoz Chemical Works, Basle, and, amongst his many activities, President of the Society for the Navigation of the Rhine, President of the Swiss Society for Economics and Delegate of the Swiss Federal and Swiss National Banks.

He was a man of fine character and possessed remarkable energy. In earlier years he spent much time in commercial improvements and the reorganisation of the Commercial School of the Society of Merchants in Basle was effected by him. During and after the Great War, Mr. Stauffacher placed his knowledge at the disposal of those dealing with economic questions and spontaneously gave whole-hearted assistance to the Basle Economical Association.

Mr. Stauffacher played a leading part in the founding of the various associated companies in the extension of the Community of Interests of the Basle Dyestuff Works and in negotiations with foreign Chemical Works. He was held in great esteem by his colleagues and employees and all who came in contact with him. His many English friends, particularly those connected with the Dyestuff and Chemical Industries, will regret the passing of this active and highly intelligent man who always had the interest of the Industry at heart.

Werner Stauffacher was 64 years of age.

THE FERMENTATION INDUSTRIES.*

By H. Lloyd Hind, B.Sc., F.I.C., and F. E. Day, B.Sc., F.I.C.

The Reports published during the last two or three years have dealt mainly with aspects of the fermentation industries leading up to the actual stage of fermentation. Recent investigations on the raw materials and the preparation of worts have been surveyed in some detail but comparatively few references have been made to advances in our knowledge of the mechanism of fermentation and its application to the technology of alcoholic fermentation. So many contributions to the scientific and practical aspects of fermentation have appeared during the last few years that limits of space have compelled the writers to confine themselves to these and to certain related work in other fields which has been helpful in the elucidation of the mechanism of fermentation.

The discovery by Buchner in 1897 that the unorganised juice expressed from yeast was capable of bringing about fermentation was fundamental in modern conceptions of the mechanism of fermentation and provided the experimental basis on which these have, in large measure, been developed. It is now quite evident that Buchner's zymase is not a single enzyme but an association of enzymes, possibly of even greater complexity than is at present realised despite the concentration of research on the enzymic aspect of fermentation and the large amount of data which have thereby been accumulated. Important advances were made when Harden and Young observed the temporary stimulation of "zymase" fermentation by disodium phosphate and the equivalence of the extra carbon dioxide produced to the amount of phosphate added, and Neuberg developed the pyruvic acid theory of fermentation. The new ideas introduced have been found applicable to all types of fermentation and to many other vital processes.

The fundamental observation of the activation by phosphate was followed by the discovery that the presence of phosphate was essential to fermentation by all yeast preparations and that the fermentation rate can be permanently raised by adding phosphate or arsenate, which stimulates the phosphatase, but neither phosphate nor arsenate accelerates the rate of fermentation with living yeast. Fermentation by yeast preparations proceeds much less rapidly than that by a corresponding amount of living yeast, but the rate of fermentation by yeast juice, for example, can be increased 10 or 20 times by the addition of phosphate, bringing the rate up to about half that of living yeast. Harden considers this to indicate that at least half of the fermenting complex has escaped injury in the preparation of the juice, but that the greater part of the mechanism for the supply of inorganic phosphate (phosphatase) has been destroyed.

In the living cell the phosphate must pass through the ester stage every five or six minutes, but in an average sample of yeast juice the cycle would last nearly two hours. Dried yeast and acetone-treated yeast occupy intermediate positions, but the addition of phosphate brings yeast juice into line with them. Harden originally explained the process as involving the formation of hexose diphosphate. The amount of carbon dioxide and alcohol formed by the addition of phosphate is equivalent to the added phosphate but under some circumstances more than 80 per cent. of the phosphate appears as monophosphoric ester. No satisfactory explanation of this discrepancy has been advanced.

Most investigations involved have necessarily been carried out, not with living yeast, but on more or less disorganised preparations of yeast. The various treatments which these have undergone must have upset the inter-relationships of the very complex enzyme systems and it becomes difficult to reconcile the results, even sometimes those of the same worker. It is now generally held, however, that the function of phosphate in fermentation is to supply, under the action of esterifying (phosphatese) and hydrolysing (phosphatase) enzymes, a mechanism for bringing the stable hexose molecules into a labile form from which triose groups are split. These at the moment of their liberation are probably also in a labile form and, in living yeast, immediately take part, probably in more than one molecular configuration, in the next stage of fermentation.

During recent years an extensive literature dealing with the filterable portion of

* Abstracted from the authors' report prepared for the Society of Chemical Industry and the Institute of Brewing.

the zymase complex, the cozymase of Harden and Young, has accumulated, but no very definite conclusions as to its nature and functions have been reached. H. von Euler and K. Myrbäck have made a detailed study of the cozymase and in the most recent of a long series of communications describe the preparation of a highly active substance related to the nucleic acids. Similar conclusions have been reached by other observers and evidence has been advanced from several sources that magnesium also plays a part in the activation of the unfilterable apozymase. In general the latest work points to the function of the cozymase being that of a powerful activator of the oxido-reduction processes which follow the decomposition of hexose phosphates. Its action appears to be complex and due to more than one constituent accelerating more than one reaction.

According to Neuberg's theory of the mechanism of fermentation two triose molecules interact at the moment of liberation from the phosphoric ester. One of these may be regarded as behaving as glyceraldehyde, the other as a hydrate of methylglyoxal or, by dehydration, as methylglyoxal aldol. The glyceraldehyde is reduced to glycerol, and the methylglyoxal hydrate oxidised to pyruvic acid. The pyruvic acid is next decomposed by the enzyme carboxylase to carbon dioxide and acetaldehyde. The acetaldehyde finally replaces the glyceraldehyde in reaction with the triose (which behaves entirely as methylglyoxal), and is reduced to alcohol, more pyruvic acid being simultaneously produced. Of the intermediate products mentioned pyruvic acid was obtained biochemically by Fernbach and Schoen (1914), and, by the addition of sulphites to fermentations, the acetaldehyde can be held back from the cycle. In this case very considerable quantities of glycerol are formed, a process which was largely made use of during the War.

Discussion still centred around the nature of the postulated triose until by treating hexose phosphate with a small quantity of dried yeast from which the cozymase had been partly removed, Neuberg and Kobel showed that methylglyoxal accumulated and could be recovered in considerable quantity. The inference is that not only is this substance (or an active triose from which it can be stabilised) the stage following hexose phosphate, but that cozymase is an activator of the succeeding reaction. By fermenting hexose phosphate with specially prepared yeast juice Neuberg and Kobel also obtained a 90 per cent. yield of pyruvic acid.

The trend of practically all resent investigation indicates that the chain of enzymic reactions already described is the basis of most of those vital processes which involve the decomposition of sugars, and the study of alcoholic fermentation has provided the key to much wider problems. Many investigators have found that the characteristic stages — hexose phosphate — methylglyoxal—pyruvic acid and often acetaldehyde—follow one another in the most varied processes. In no case has the succession been traced in such detail as in alcoholic fermentation, but it is remarkable that the process of esterification is the same in glycolysis by muscle juice as in alcoholic fermentation by yeast juice and that the coenzyme of the muscle enzymes is identical with that of zymase and that, according to Meyerhof, both are similarly activated by arsenates, whilst Ariyama has obtained methylglyoxal by the action of muscle tissue freed from glyoxalase on hexose phosphate.

Pasteur regarded the fermentative and respiratory functions of yeast as independent and in some sense reciprocal. In this view he was supported by Nägeli and others, whilst Schützenberg and Pfeffer held that the two processes were intimately related. Pasteur's view that fermentation and respiration were two independent functions of the living cell was apparently confirmed by Meyerhof (1925), who found that the relation between the two activities varied greatly with different yeasts, and by Warburg (1926).

It may be emphasised that respiration is not, as was formerly thought, essentially an oxidation of carbon. In the process, as now conceived, the carbon dioxide is liberated from pyruvic acid by carboxylase before oxygen enters into the reaction. As a result substances are produced of which certain hydrogen atoms are capable of activation by dehydrogenases and it is this hydrogen which combines with oxygen in respiration. Gay Lussac's equation for fermentation would express in the simplest way the anaërobic phase, with the evolution of carbon dioxide, although the oxidation in the aërobic phase would occur further back in the fermentation process than at the alcohol given in it. An explanation has been suggested for the introduction of

oxygen into the process of respiration, but the mechanism of the subsequent stages of re-synthesis of hexose is unkown. Enzymic actions of the type referred to "carboligase" by Neuberg and Hirsch in 1915 have been shown by Stepanov and Kusin to be brought about by preparations from the leaves of many plants. It is quite possible that dehydrogenase action may prove to be the key to this problem through the production of acids. The catalytic scheme formulated by Blackman to account for the respiration phenomena in stored apples is based on a typical zymase mechanism for the anaërobic phase, while a re-synthesis by way of acids is suggested.

Support is lent to this view by the biochemical synthesis of citric acid by certain fungi. T. Chrzaszcz and D. Tiukow have, for example, shown that citric acid is formed by the action of certain *Penicillia* on sodium acetate. They suggest that the reaction may be: hexose ⟶ methylglyoxal ⟶ pyruvic acid⟶acetic acid. Then two molecules of acetic acid would be dehydrogenated to succinic acid, which is converted into malic acid, while malic acid and a third molecule of acetic acid yield citric acid. K. Bernhauer and H. Siebenäuger have confirmed this in that they find that certain strains of *Aspergillus niger*, when allowed to act on sodium acetate, sodium malate, or sodium glycollate, yield citric acid. H. Raistrick and his co-workers in the course of an extended series of investigations of the metabolic products of certain moulds, have demonstrated the synthesis from glucose of a number of very complex substances in addition to such simpler compounds as succinic, malic, and gluconic acids, mannitol, and glycerol. The presence of iron as an essential constituent of the media in some of the reactions described appears to support the claim of O. Warburg (1923) that iron was the essential oxygen carrier in respiration. It certainly occurs in most living cells, is rapidly oxidised and reduced, and forms stable compounds with hydrocyanic acid which inhibits respiration but not fermentation.

The general trend of research has thus been towards the view that there is much in common between fermentation and respiration, if indeed they do not depend mainly on the same enzymic mechanism.

Practical Applications.

Advances in knowledge of the mechanism of fermentation have generally only served to explain the course of technical operations in the older industries for which appropriate conditions have been empirically discovered, but in some instances they do indicate the possibility of improvement in technique or in methods of control. They have, however, had a more direct influence on the establishment of the newer fermentation industries.

From the technical point of view the problems of the enzymic processes within the yeast cell are of less immediate importance than those relating to the conditions which give satisfactory fermentations and good yeast crops. Though the two are intimately connected the complexity of the former group of problems involves slow progress, whilst results of technical value can often be more readily obtained by studies of fermentations conducted along lines approximating to those occurring under industrial conditions. Experimental evidence of the deterioration of yeast resulting from aëration was obtained by F. Windisch. Vigorous aëration at the time of pitching and once daily during the first four days of fermentation increased the rate of fermentation and the amount of reproduction, but the yeast underwent a progressive deterioration. The cells became smaller and less uniform with greater granulation and smaller vacuoles. Under normal conditions of fermentation, aëration had practically no effect if delayed until reproduction had ceased. After three successive fermentations with aërated yeast the attenuations became incomplete and the author concluded that undue aëration is responsible for many cases of rapid enfeeblement of yeast and unsatisfactory after-fermentation. He also came to the conclusion that the stimulating effect of rousing on fermentations was partly due to a surface effect similar to that which inert substances, having a large surface, exert if present in fermenting liquids, as well as to the increased reproduction brought about by the aëration, but that motion itself did not effect the rate of fermentation.

The general substitution of other materials for wood in the construction of tions in experimental conditions. The realisation that constancy in fermentation and regularity of product could be assured only by the use of yeast raised from a single cell and maintained in a state of purity led Hansen to introduce the use of pure yeast fermenting vessels has introduced various

problems that were not formerly encountered. The surface of the material of which the vessel is constructed may influence the course of fermentation. F. Emslander observed in bottom fermentations in enamelled iron fermenting vessels that the krausen always appeared much sooner above attemperating tubes of tinned copper than elsewhere. If paraffined enamelled iron plates are suspended in a fermenting vessel, the paraffined surface becomes rapidly coated with bubbles. The negatively charged paraffin attracts positively charged carbon dioxide and colloids dissolved in the wort. These are discharged at the negative surface and give neutral gas bubbles and precipitated colloids. Bare enamel surfaces are positively charged and repel these substances. No doubt electrical phenomena play a part in the clarifying action of chips in storage vessels and in the varying course of fermentation in fermenting vessels and different materials or surfaces.

The possibility of corrosion or injurious effects on fermentation from electric currents in metallic vessels has frequently given rise to disquiet. The use of copper attemperators in aluminium vessels has, for example, led to serious corrosion and Emslander has measured the electric currents passing between coils and vats, even when no apparent connexion exists. He detected a slight difference in potential above and below the liquid in aluminium vessels partly filled with liquid and observed a tendency to corrosion at the surface. In enamelled iron vessels currents may pass between the attemperating coils and the metal of the vessel, despite the insulating material, but such currents are extremely slight. Fissures caused by swelling of the concrete due to electrolytic action on the embedded iron rods have been observed in, possibly badly constructed, reinforced concrete vessels. Usually the iron is protected by the alkalinity of the concrete and galvanic action should not occur.

The purity of race of the yeast used in experimental investigations has not been stressed but it is evident from the variations in the metabolism of different species how essential it is that fundamental research should be conducted on pure cultures. In many cases the contradictions encountered may be due as much to the employment of different strains as to variain brewery fermentations in 1883. No single advance in the technology of fermentation has had wider influence than this. In many of the newer fermentation industries adoption of the principles involved has been an essential factor in their success.

DR. DAVIDSON ELECTED VICE-PRESIDENT OF THE CARBIDE AND CARBON CHEMICALS CORPORATION, NEW YORK.

According to an announcement by Mr. J. A. Rafferty, President, Carbide and Carbon Chemicals Corporation, 30 East 42nd Street, New York, N.Y., Dr. J. G. Davidson was elected vice-president of the Corporation at a meeting of the Board of Directors held on January 14, 1932. Dr. Davidson, who served the Corporation as director of chemical sales during the period 1928-30 and later, during 1930-1, as general sales manager, has been notably successful in chemical industry since the conclusion of his scientific investigations at Mellon Institute in Pittsburgh. He has devised and applied a number of novel and effectual procedures in chemical merchandising research, and has distinguished himself by utilising effectively the results thereof in introducing new chemicals, the scientific creations of the Carbide and Carbon Chemicals Corporation, to the chemical profession, to the industries, and to the public. In thus cultivating fields of uses for novel chemical products, he has served valuably both science and technology.

Dr. Davidson was born in New York in 1892. He received his under-graduate training in chemistry at the University of Southern California, where he was awarded the degree of A.B. in 1911. He then pursued a year a graduate work in that institution, securing his A.M. in 1912. He served as instructor in chemistry at Los Angeles Junior College during 1914-16, and in 1917 was given a fellowship at Columbia University. In 1918 Columbia conferred on him the degree of Ph.D. and shortly thereafter he became an industrial fellow and later a senior fellow of Mellon Institute, a post that he occupied with conspicuous success until he entered the employ of the donor of his fellowship, the Carbide and Carbon Chemicals Corporation. During his work at Columbia and later at Mellon Institute, Dr. Davidson specialised in hydrocarbon chemistry.

A CHART OF ATOMIC STRUCTURE

By Professor Ingo W. D. Hackh,

The purpose of this chart is to serve as a reference table for the structure of the atoms, its nucleus and surrounding electron shell, and the periodicity of these characteristic features.

For convenience the chart is divided into three sections. The middle of each section is occupied by the atomic number, below this the graph shows the isotopes and their nuclear structure; above the distribution of the electrons outside the nucleus. The arrangement of the chart is the obvious conclusion of a study of the radioactive elements and their structure[1] and as such is an extension of a chart published recently[2] so as to include all elements. There are a number of interesting facts revealed by a study of this chart which lead the author to the conclusion that *the number of possible helium particles in the nucleus cannot exceed one-half the atomic number.* This is in direct contradiction to the assumptions made by Harkins[3], Urey[4] and Latimer[5], all of which use different combinations of a) helium nuclei, b) additional binding electrons or cementing electron pairs, and c) additional protons and electrons in order to make up the isotopic weight.

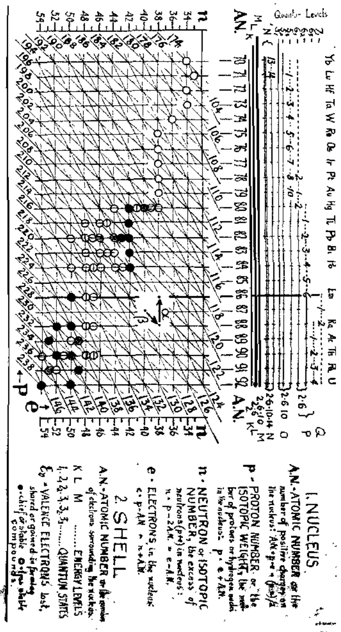
Isotopes and Nuclear Structure.

A system of four co-ordinates is employed to plot respectively (*a*) the atomic number or the positive charge on the nucleus, AN. (*b*) the isotopic number or the number of neutrons, n. (*c*) the proton number, or the isotopic weight, p. (*d*) the number of nuclear electrons, e.

Any two of these numbers will thus fix the other two, as the following simple relations exist :—

$$AN = p - e \text{ or } e - n$$
$$n = p - 2AN \text{ or } e - AN$$
$$p = AN + e \text{ or } 2AN + n$$
$$e = p - AN \text{ or } AN - n$$

Thus by plotting isotopic weight, that is the proton number, p, against atomic number AN, the number of nuclear electrons and neutrons can be readily read from the table. Only those isotopes which are actually known have been plotted in the chart. However, since its construction the following isotopes have been announced by Aston, Urey and others and should be added to the chart :—



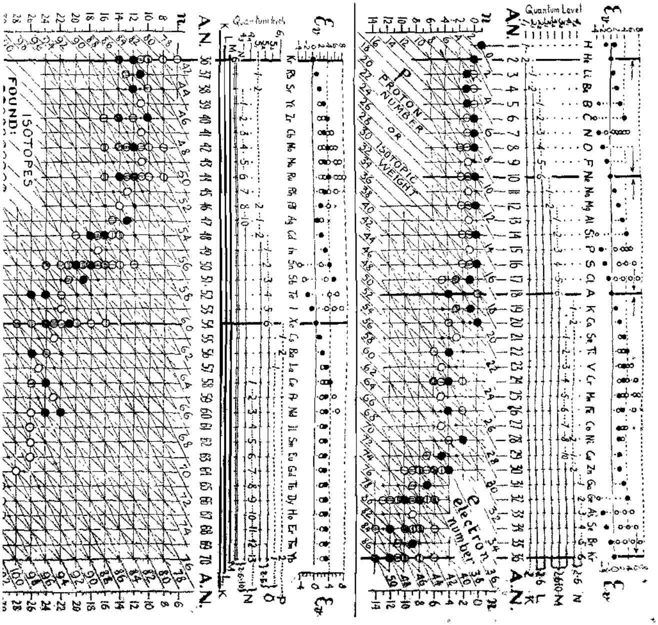
[1] Hackh, *Phys. Rev. 13*, 165, 1919, *Phil. Mag. 39*, 155, 1920.
[2] Hackh, *Science*, 74, 490, 1931.
[3] Harkins, *Phys. Rev. 38*, 1270, 1931.
[4] Urey, *J.Am.C.S.*, *53*, 2872, 1931.
[5] Latimer, *J.Am.C.S.*, *53*, 981, 1931.

AN		P
1	hydrogen	1, 2
38	strontium	88, 86, 87
56	barium	138, 137, 136, 135
74	tungsten	184, 186, 182, 183
75	rhenium	187, 186
76	osmium	192, 190 ,189, 188, 186, 187

In order to illustrate the importance of these isotopes, their relative abundance is indicated by a solid circle for the most abundant species, gradually less and less shading for those less and least abundant. Elements of which at present no isotopes are known, have a white circle. No attempt has been made to list predicted isotopes, of which many can be added in order to complete the symmetry of the pattern.

It is naturally possible to assume many different ways in which the protons and electrons of the nucleus are combined, for there is at present no experimental evidence, except radioactive decay, which will give weight to one or the other assumption. In radioactive decay, however, we find that alpha-particles or p_4e_2 are alone responsible for the changes in the isotopic weights. If one now assumes that these alpha-particles, having a net positive charge of two, are also responsible for the positive charge on the nucleus, it follows that the number of isotope of an element has the same number

A Chart of Atomic Structure.



alpha-particles must be AN/2. If this very simple relation holds, it follows that every of alpha-particles; thus the eleven isotopes of tin have 50/2 or 25 alpha-particles and their difference in atomic mass is made up of neutrons, *pe*, which are the ballast of the atom. The existence of neutrons, that is a proton and electron combined, becomes plausible by the singular fact that in *each* case the number of protons equals the number of electrons when the number of protons and electrons of AN/2 alpha-particles is subtracted from the total number of protons and electrons. Thus Pb^{206} has 206 protons and 124 electrons in its nucleus. Its atomic number is 82, and subtracting 82/2 or 41 p_4e_2, that is 164 protons and 82 electrons leaves 42 protons and 42 electrons, which are assumed to be present as 42 neutrons.

The atomic nucleus consists then of

(*a*) *alpha-particles* or helium nuclei, α or p_4e_2 the number of which is equal to half the atomic number, and thus ranges from O for H to 46 for U;

(*b*) *half alpha-particles*, $\alpha_{0\cdot5}$ or p_2e, only one of which occurs in each element of odd atomic number. These are relatively unstable and less abundant. The isotope of hydrogen H^2 is probably such a particle : $p_2e = pe + p$.

(*c*) *neutrons*, n or *pe*, the number of which is equal to the isotopic number, that is the isotopic weight or proton number minus twice the atomic number, it ranges from 0 to 54 and can be considered the ballast of the nucleus.

With this concept it becomes possible to interpret radioactive disintegration and to conclude[6] that during alpha-decay an alpha-particle is lost from the nucleus, while during a beta-decay a half alpha-particle is formed from two neutrons: $2pe \longrightarrow p_2e + e$; and as two beta-decays follow each other usually in rapid succession, the net result is the loss of four neutrons: and the reconstruction of an alpha-particle: $2p_2e \longrightarrow p_4e_2$.

While the number of isotopes which are actually known is still below the number of isotopes which exist, there is nevertheless sufficient ground for comparing the known with the missing and probable isotopes. In the following table are listed the number of isotopes as separated into the four series of the proton numbers: 4n, 4n+1, 4n+2 and 4n+3. The number actually known is in parenthesis, while the possible number of proton numbers is without parenthesis.

The doublets, triplets and one quadruplet bring the number of known isotopes up to 238, distributed over 179 proton numbers out of 235 possible proton numbers. In the first section from He to Ce the missing proton numbers as listed under a, d, g, j will be found, those of d being the rarest and least abundant. Characteristic of this section is the fact that the isotopes of the first two periods, from Li to Cl of all elements with odd atomic number, are in the series 4n+2 and 4n+3, while the isotopes in the next two periods, from K to Cs, of all the odd numbered elements into series 4n+1 and 4n+3, the only exception being Rh 98 and I 128.

In the next section from Ce to Au our knowledge of isotopes is at present limited and there will be undoubtedly many found which must be added. It is at present not possible to say whether or not the odd numbered elements show the same characteristic. The only peculiarity is the absence of isotopes in the series 4n+1. Of the 25 proton numbers of this series, 141 to 237 inclusive, there are only the three isotopes Re 185, Os 189 and Hg 201 known, signifi-

[6] Hackh, *J.A.C.S.*, 54, Feb. 1932. (Forthcoming communication.)

DISTRIBUTION OF ISOTOPES AMONG PROTON NUMBERS.

Series	Proton numbers from to	Section from He to Ce	Ce to Au	Hg to U	Total He to U
4n	4 to 236	35 (34[a])	14 (12[b])	10 (9[c])	59 (55)
4n+1	5 to 237	34 (27[d])	14 (2[e])	11 (1[f])	59 (30)
4n+2	6 to 238	34 (30[g])	14 (11[h])	11 (11[i])	59 (52)
4n+3	7 to 235	34 (30)	14 (3[k])	10 (9[l])	58 (42)
Total		137 (121)	56 (28)	42 (30)	235 (179)

		Missing *Isotopes are*	*Doublets*	*Triplets*	*Quadruplets*
			in this section are:		
4n	a	108	10	1	—
	b	172, 174	—	—	—
	c	236	2	3	—
4n+1	d	5, 49, 57, 61 105, 125, 133	4	—	—
	e	known are 185, 189	—	—	—
	f	known are 201	—	—	—
4n+2	g	38, 42, 46, 62	11	1	—
	h	154, 158, 166	2	—	—
	i	none	—	2	1
4n+3	j	43, 47, 91, 127	5	—	—
	k	kn. 175, 183, 187	1	—	—
	l	203	2	2	—
		Total	37	9	1

cant is also that among the radioactive elements, there are *no* isotopes having a mass of 209, 213, 217, 221, 225, 229, 233 and 237— for this reason one may say that proton numbers of the series 4n+1 are almost forbidden, except between 9 and 137.

The last section, from Hg to U covers the radioactive elements and seems thus fairly complete, except for the series 4n+1. There is one quadruplet at 210: Tl, Pb, Bi, Po and 7 triplets.

The number of nuclear electrons show similar regularities; thus 50 and 82 nuclear electrons each occur in 6 isotopes, while 3 or 2 isotopes for each number of nuclear electrons is the average. So far the only numbers of which no isotopes are known are those with 90, 94, 98, 102 nuclear electrons. Odd numbers, however, have generally a smaller number of isotopes, the ratio being about 1 : 3, that is even numbered electron numbers occur in about three times as many isotopes.

The chart, then, enables one to read off the number of protons and electrons in the nucleus and to distribute these number of protons and electrons among alpha-particles and neutrons; thus, the isotopes of zinc have the following nuclear composition:

AN 30	Zn	64	$p_{64}e_{34}$	or	$\alpha_{15}n_4$
	Zn	65	$p_{65}e_{35}$	or	$\alpha_{15}n_5$
	Zn	66	$p_{66}e_{36}$	or	$\alpha_{15}n_6$
	Zn	67	$p_{67}e_{37}$	or	$\alpha_{15}n_7$
	Zn	68	$p_{68}e_{38}$	or	$\alpha_{15}n_8$
	Zn	69	$p_{69}e_{39}$	or	$\alpha_{15}n_9$
	Zn	70	$p_{70}e_{40}$	or	$\alpha_{15}n_{10}$

while

AN 31	Ga	69	$p_{69}e_{38}$	or	$\alpha_{15\cdot5}n_7$
	Ga	71	$p_{71}e_{40}$	or	$\alpha_{15\cdot5}n_9$

where a half-alpha particle is present.

Electronic Shell and Valency.

The upper portion of each section of the chart illustrates the periodicity of the electrons surrounding the nucleus and of the valency. The distribution of the electrons in the different quantum levels or K, L, M, N, etc., orbits is shown by listing the number of electrons, a solid line meaning that that particular level is filled up, a dotted line indicates the level which is being filled or incomplete. The periodicity is shown by comparing elements of a certain group, thus *e.g.*, K, Ca with Rb, Sr, and Cs, Ba, etc. Again the difference between the heavy metals and the rare earths is brought out by illustrating that the first differ by electons in the second outermost shell, whereas the latter differ by electrons in a level having two completed and two half-completed outer levels.

The valency, that is the number of electrons which can be lost or gained is shown in the topmost row where a solid dot indicates the principal valence (the one shown by the most stable or numerous compounds) and a circle indicates the other valencies or states of oxidation and reduction of that particular element. Here again the periodicity, the regular rise and fall is clearly seen, likewise the similarity in the periods of the heavy metals from 23 V to 31 Ga, from 41 Cb to 49 In, and from 73 Ta to 81 Tl. as well as the beginning and end of each period. The reason of the tri-valency of the rare earth becomes likewise evident, as there are but 2 and 1 electron in the outermost or valency levels. The arrows at the top, pointing toward the rare gas, indicate the direction in which the element gains or loses electrons, thus K loses one and K^+ resembles A in its electronic arrangement, while Cl will gain one and Cl^- likewise resembles A (as an isostere).

Chemical Laboratories,
College of Physicians and Surgeons,
San Francisco.

NOTED EUROPEAN SCIENTIST JOINS EDITORIAL BOARD OF " CHEMICAL NEWS."

One of the most distinguished Czechoslovak men of science, Dr. Cyrill K. Krauz, Professor of Organic Chemistry at the Prague Technological University, has joined the Editorial Board of THE CHEMICAL NEWS. Prof. Krauz has had wide experience in various parts of Central Europe and Russia and has made a life study of Applied Organic Chemistry, particularly in the branches of Explosives and Drying Oils. His researches in these subjects are well-known to readers of THE CHEMICAL NEWS since Prof. Krauz has frequently published papers on these matters in our columns during the last decade. Like most other distinguished continental chemists, Prof. Krauz has a perfect command of several languages besides his own and on occasion has advocated the wider use of English as *the universal language*.

He is also an authority on Chemical Engineering and took a prominent part in the Engineering Congress at Mladá Boleslav in Czechoslovakia in 1926.

Prof. Krauz is always a welcome visitor to England and now that he has joined THE CHEMICAL NEWS Editorial Board we trust his visits will be more frequent than ever.

ALUMINIUM PRODUCTS INDUSTRY IN CANADA.

Canada is now one of the largest producers of aluminium in the world, and an immense plant for the production of this metal is now producing at Arvida in the vicinity of Lake St. John, Quebec. For the supply of energy to this plant, a hydro-electric power station is being constructed on the Sanguenay River, which will have an eventual output exceeding 1,000,000 h.p.

LEAD, TIN AND ZINC PRODUCTS INDUSTRY IN CANADA.

During the past few years the production of lead and zinc in Canada has been making notable increases, particularly in British Columbia, and there has been until recently an expansion in those industries associated with the production of manufactured products utilising as their raw material lead, zinc and tin. In 1930, the production of this group of manufacturing plants was valued at $5,178,588, twenty per cent. less than that for 1929.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

Thursday, February 25.

The following papers were read : —

A Comparative Study of the Phosphagens, with some remarks on the Origin of Vertebrates. By D. M. NEEDHAM, J. NEEDHAM, E. BALDWIN and J. YUDKIN. Communicated by Sir F. Gowland Hopkins, F.R.S.

A systematic survey has been made of the phosphagens of Invertebrates, and it was found that arginine phosphate exists in all the Phyla of which representatives were studied, though in the Cœlenterates it was only found in a Ctenophore. Evidence is brought forward to suggest that arginine phosphate may be associated with ciliary as well as muscular movement. Creatine phosphate is not confined to the Vertebrates, but was found to be present in (*a*) Echinoderm jaw muscle and (*b*) Enteropneust tissues.

If any evolutionary significance may be attached to these findings, it is probable that they support the Echinoderm-Enteropneust theory of Vertebrate descent (Bateson : MacBride : Garstang), rather than any of the other views which have been suggested from time to time.

Myotatic Reflexes in Sympathetomised Muscle. By G. PHILLIPS. Communicated by Sir Charles Sherrington, F.R.S.

After excision of its sympathetic innervation skeletal muscle exhibits quantitative changes in proprioceptive reflex activity. These changes develop and become most prominent some weeks after sympathectomy.

Simultaneous myotatic contractions of two soleus muscles when subjected to the same passive stretch have been recorded by a " double " isometric myograph and a twin string galvanometer. Three conditions of stretch-stimulation have been regarded as essential in making comparable records. These are : a small passive increment of length performed at an even rate from an initial posture of minimal tension.

Under such conditions the latent period of the myotatic reflex determined by the time of onset of the first action current wave is shorter in the sympathectomised

muscle. It has also been observed that while the tension of the myotatic contraction in the normal soleus is, within limits, but little influenced by the rate of application of stretch, that of the sympathectomised muscle is greatly modified by *grading the rate at which it is stretched.* There is a critical rate (about 3 mm. in 0.25 sec.) at which both muscles attain approximately the same maximum tension : at rates faster than this the sympathectomised *muscle attains a greater maximum tension* and at slower rates it attains a lower tension than the normal muscle.

Soleus muscle deprived of its sympathetic innervation some weeks previously loses in great degree its power of maintenance of any postural contraction of other than low tension : *under slight persistent stretch it* exhibits a marked tendency to display clonic movements which are distinguished from the normal muscle clonus by their faster rate and lower tension change.

The muscle jerks elicited at low initial tension are characterised by a greater mechanical tension and a longer "silent period" in the galvanometer string record of the sympathectomised muscle.

Large compound action current waves, alternating with short "silent periods" in the electrical records from sympathectomised muscle suggest incompletely synchronised activity in several anterior horn cells.

It may be said that the available evidence denies the existence of any sympathetic nervous mechanism responsible for the direct qualitative control of postural reactions, and argues that the quantitative changes following sympathectomy are produced by a disturbance of the excitability of proprioceptive end-organs in sympathectomised muscle.

The Rhythmic Discharge of Motoneurones. By J. C. Eccles and H. E. Hoff. Communicated by Sir Charles Sherrington, F.R.S.

In a general discussion of the experimental observations on the factors affecting the rhythmic discharge of a motoneurone, the events during the rhythmic cycle have been described in terms of the "activity" of the rhythmic centre, by which is meant the propensity of the rhythmic centre to set up a reflex discharge.

Equations based on certain assumptions have been worked out which are in satisfactory agreement with the experimental observations.

THE PHYSICAL SOCIETY.

March 4, 1932.

The following papers were read :—

A Vacuum Calorimeter for High Temperatures. By L. G. Carpenter, B.A., B.Sc., and T. F. Harle, B.Sc.

A form of the platinum-thermometer type of vacuum calorimeter has been developed which is suitable for the determination of *true specific heats at high temperatures,* since it is constructed without any organic insulating materials. The design is novel in that the heat is transferred from the platinum coil to the calorimeter by radiation. The general principles of vacuum calorimetry are discussed and applied to the design of the present calorimeter, and a full description of the constructional details and experimental procedure is given.

A New Tilted Electrometer. By Hugh Carmichael, B.Sc.

A description is given of the construction and performance of a new electrometer on the principle of the Wilson tilted gold-leaf electrometer. The instrument has a quartz fibre "leaf" which moves in hydrogen to reduce sluggishness. There is complete protection of the instrument from atmospheric disturbance, and considerable simplifications are made in the construction and in the method of adjustment. Typical sensitivities of 3 mm. and 30 mm. fibre movement per volt (linear for 2 mm. and 1 mm. respectively) have been obtained, and a reliable eye-piece scale sensitivity of 1000 divisions per volt is within the range of the instrument.

The Symmetrical Modes of Vibration of Truncated Conical Shells with Applications to Loud-speaker Diaphragms. By N. W. McLachlan, D.Sc., M.I.E.E.

It is shown that in general the stresses in vibrating conical shell are so complicated that the problem is unsuited to analytical treatment. If the stress were purely extensional, the frequency would be independent of the thickness t and vary inversely as the major radius a. This, however would

necessitate a much larger potential energy at the small end than practice indicates. The expression for the frequency of a shell of constant minor radius is of the form $f = kt^{n_1} a^{-n_2}$ where, for certain conditions, $n_1 = 0.22$ and $n_2 = 0.67$.

Experimental work with paper, glass and aluminium shells is described. The modes crowd together as compared with the segregation which occurs in the case of a disc. With thick glass or aluminium of comparatively low loss, the nodal frequencies are very clearly-defined peaks. In the case of paper cones driven by coils of small mass, the peaks disappear and the nodal region is indicated by a broad rounded contour. The influence of thickness, apical angle and the mass of the driving coil are treated. Vibrations of the air column within the shell and the general requirements for loud-speaker diaphragms are discussed and illustrated by practical examples.

RADIUM DEVELOPMENTS IN ONTARIO.

A progress report issued by International Radium and Resources, Limited, states that headway has been made towards the completion of the 150-ton mill now being installed at the Wilberforce (Ontario), property. The ball mill and classifier are in place, and the gyratory crusher will be installed shortly. It is planned at the beginning to operate the mill at 100 tons capacity and to step it up later. A contract has been made with an English firm for the supply of radium concentrates. The main effort of the Company in recent weeks has been confined to construction work.

UNITED STATES OF AMERICA.

A copy of a confidential memorandum on the potential market for United Kingdom goods in the States of Michigan and Ohio prepared by H.M. Consul at Detroit has been issued to firms whose names are entered on the Special Register of the Department of Overseas Trade.

United Kingdom firms desirous of obtaining a copy of this memorandum together with particulars of the Special Register service of information should apply to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. Reference number C.X. 3811 should be quoted.

Notices of Books.

Sulphur Bacteria. By Dr. David Ellis. Pp. xii+261. London: Messrs. Longmans, Green and Company. 1932. Price 21s.

The name *Sulphur Bacteria* is given to a group of organisms which have sulphur globules in their cells. Actually they include a wide variety of forms and sizes, some being structually similar to the bacteria, bacillus, coccus and spirillum, whilst others are filamentous and at least one is large enough to permit of microtome sections being made from it. They are usually classified into coloured (purplish) and colourless sulphur bacteria and can effect a variety of changes which may be epitomised Sulphide $\rightleftharpoons$ Sulphur $\rightleftharpoons$ Sulphate

Researches in these organisms have been undertaken by a number of investigators, including Dr. David Ellis, who has made a special study of the coloured organism *Thioporphyra volutans.* This work has undoubtedly shed much light on the nature and behaviour of these curious low plants and constitutes chapter VIII of the author's present monograph. The book covers the whole field; all groups and every individual sulphur bacterium are described fully and emphasis is rightly given to the importance of these bodies in natural economy. They "constitute a cog in the machinery of life, a breakdown in which would sooner or later result in the elimination of mankind and the higher animals."

The study of sulphur bacteria supplies matter of importance and interest to scientists in general, but especially to the botanist, bacteriologist, analyst and chemist, to all of whom this book is strongly recommended.

Uvoddoradiaktivity (*Introduction to Radioactivity*). By F. Behounek and J. Heyrovsky. Pp. 116, 58 fig., 7 plates and 5 tables. Published by the Jednota Cs. matematiku a fysiku. Series "Kruh," Vol. 9. Prague. 1931, Price 24 Czech crowns.

This is the first book on radioactivity in all its different aspects written by Czech authors, though radium was discovered in uranium ores of Bohemian origin which still supply the world with radium preparations containing the least quantity of the isotopic members of the thorium family.

The aim of the authors was to place in the hands of the uninitiated student and of the general reader interested in science a guide which would enable him to study with profit the more advanced text-books, but parts of the book are meant also as a short manual to be used by students attending the laboratory exercises conducted by the writers in the Charles' University of Prague.

It is very apt that the authors have dedicated their little volume to the memory of their distinguished teacher, the late Professor B. Kucera, who was the first Czech worker in the field of radioactivity and a very active promoter and organiser of the Czechoslovak State Radiological Institute at Prague. The book is adorned with his full page portrait, and also with those of H. Becquerel, M. Sklodowska-Curie, P. Curie, Lord Rutherford, F. Soddy and Sir William Ramsay.

The book is divided into the following sections: 1, Discovery of radioactivity. 2, Radioactive transformation. 3, Structure of atoms and atomic numbers. 4, Transmutability of elements. 5, Isotopy. 6, Making of radioactive preparations. 7, Use of radioactive substances. 8, Physical and chemical effects of radiactive radiations. 9, Their physiological effects. 10, Radioactivity and Geophysics. 11, Cosmic radioactivity. 12, The State Radium Mines. 13, Methods of measurement. A list of 27 text-books and monographs bearing on radioactivity is appended. The presentation of the matter is very vivid and clear. Stress is laid on the experimental side of the subject directions being given how to perform the experiments described with quite simple means. In comparison with other books of this kind the chapters 7, 9 and 12 are a characteristic feature of this volume which is richly illustrated with diagrams and photographs throughout. The reviewer calls in this respect a special attention to the beautiful photographs demonstrating the influence of radioactivity radiation on the growth of plants and the germinating of seeds, and the cardiogram showing the restoration, by radon, of the automatic activity of frog's heart which had been paralysed before owing to lack of potassium. The treatment of the matter in chapter 3 is intentionally rather condensed in view of the fact stated expressly by the authors that there exists a Czech translation of A. S. Russell's Introduction to the chemistry of radioactive substances.

The book fills a real gap in Czech semipopular scientific literature and its perusal can be warmly recommended to the circle of those who are seeking the information it promises to convey.

A. Simek.

Forthcoming Events.

THURSDAY, MARCH 10.

S.C.I. *Nottingham Section.* Joint meeting with the Institute of Fuel. University College, Nottingham, at 7.30 p.m. "Economics of High Temperature Carbonisation," by Dr. E. W. Smith.

S.C.I. *Liverpool Section.* University, Liverpool, at 6 p.m. Joint meeting with the Liverpool and North Western Section of the Institute of Chemistry. Paper by F. Grimshaw Martin.

Institute of Chemistry. *Manchester and District Section.* College of Technology Manchester, at 7 p.m. Annual General Meeting. "Mechanism of Chemical Change," by Dr. T. M. Lowry, F.R.S.

Institution of Electrical Engineers. Victoria Embankment, W.C.2., at 6 p.m. "Modern Boiler Plant," by J. Bruce.

Chemical Society. *Third Pedlar Lecture.* Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, at 5.30 p.m. "The Life and Work of Otto Wallach," by Prof. L. Ruzicka.

Optical Society. Imperial College of Science and Technology, South Kensington, at 7.30 p.m.

Oil and Colour Chemists' Association. *London Section.* 30, Russell Square, W.C.1, at 7.30 p.m. "Synthetic Resin Finishes," by H. Houlston Morgan.

FRIDAY, MARCH 11.

S.C.I. *South Wales Section.* Joint meeting with the local section of the Institute of Chemistry. Technical College, Cardiff, at 7.30 p.m. "Chemical Constitution of Coal," by S. G. Ward.

Institute of Chemistry. *South Wales Section.* Joint meeting with the local Section of the S.C.I. (See above.)

S.C.I. *Bristol Section.* Bristol University, at 7.30 p.m. "*Audiovisors.*"

S.C.I. *Newcastle Section.* Joint meeting with Coke Oven Managers' Association, Northern Section. "Petrol from Coal," by M. P. Applebey.

Coke Oven Managers' Association. Northern Section. Joint meeting with the Newcastle Section of the S.C.I. (See above.)

Institution of Mechanical Engineers. Graduates' Section, London. Annual Dinner.

MONDAY, MARCH 14.

S.C.I. *Edinburgh and East of Scotland Section.* Annual General Meeting. Joint meeting with the local section of the Institute of Chemistry. 36, York Place, Edinburgh, at 7.30 p.m. "Plating," by J. G. Roberts.

Institute of Chemistry. *Edinburgh and East of Scotland Section.* Joint meeting with the local Section of the S.C.I. (See above.)

Biochemical Society. Annual General Meeting, University College, Gower Street, W.C.1., at 3 p.m. "Activity of Crystalline Insulin," by K. Culhane and G. N. Greenwood. "Crystallographic Examination of Oestrin," by J. D. Bernal (introduced by G. F. Marrian). "Monomolecular Films of Oestrin Derivatives," by N. K. Adam, J. F. Danielli, G. A. D. Haslewood, and G. F. Marrian. "Creatine and Phosphorus Compounds in Tumours," by E. Boyland. "Accurate Titration of 'Free HCl' of Gastric Contents, Peptic Digests, etc.," by G. M. Richardson. "Importance of the Basal Diet for Vitamin-A Tests," by K. Culhane. "Influence of Light White Casein on the Onset of Xerophthalmia," by K. Culhane.

Institution of Mechanical Engineers. Graduates' Section, London, at 6.45 p.m. Annual Lecture. "Strength and Behaviour of Steels at High Temperatures," by W. H. Hatfield.

WEDNESDAY, MARCH 16.

S.C.I. *Liverpool Section.* Annual Meeting. University, Liverpool, at 6 p.m. "Evaluation of Wood Pulp for Strength," by Dr. H. Ainsworth Harrison. Visit to Messrs. Bowater's Mersey Paper Mills, Ellesmere Port.

FRIDAY, MARCH 18.

S.C.I. *Birmingham and Midland Section.* Joint meeting with the Chemical Engineering Group. Chamber of Commerce Buildings, Birmingham, at 6.45 p.m. "Some Characteristics of Nickel and its Alloys," by W. R. Barclay.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by permission of the Controller of H.M. Stationery Office and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., price 1/- weekly (annual subscription, £2 10s.).

Latest Patent Applications.

4,588.—Anderson, L. J.—Production of titanium oxide. February 16.

4,527.—*Lawarree, H.—Manufacture of* sodium bicarbonate. February 16.

Abstract Published.

362,195.- Esters of sulphonated acids.—Bohme Akt.-Ges., H. T., 29, Moritzstrasse, Chemnitz, Germany.

Esters of sulphonated higher dibasic and polybasic aliphatic acids are produced by sulphonating and esterifying the acids simultanously or successively. The acids may be produced by adding hydrocyanic acid to the double bond of an unsaturated acid such as ricinoleic acid, and saponification of the nitrile. The acid may be completely or partly esterified with an aliphatic, alicyclic or aromatic alcohol (other than glycerin) or phenol and the ester then sulphonated for instance with sulphuric acid, oleum or chlorsulphonic acid in presence or not of organic or inorganic water-fixing agents such as acids or acid derivatives and with or without sulphonating catalysts such as kieselguhr or animal charcoal; or the esterification and sulphonation may be effected in one operation by adding the alcohol or phenol to the sulphonation mixture or to one of its components. In an example the dibutyl ester of the dicarboxylic acid obtained from ricinoleic acid is sulphonated below 15° C. with sulphuric acid of 66° Bé, ice is added and the mass is washed with sodium sulphate solution. The product neutralised in the usual manner is readily soluble in water and may be employed in the same manner and for the same purposes as indicated in Specification 315,882 [*Class* 2 (iii), Dyes, etc.], that is to say as a wetting agent for the leather and textile industries, for the moistening, etching, and corrosion of metals, and for wetting powders, colours, or dyestuffs, and for emulsifying and fat-cleaving.

THE CHEMICAL NEWS

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Nickel as a Catalyst in Chemical Reactions*

BY M. PAUL SABATIER.

Photo by courtesy of The Mond Nickel Co. Ltd

M. Paul Sabatier, born in the well-known historical town of Carcassonne, graduated from the Ecole Normale Supérieure, where he was awarded the highest degree in Physics. He was for some time the assistant of Berthelot at the Collège de France, and since 1882 has been Professor of the Faculté des Sciences in Toulouse, occupying the position of Senior Professor for the past 26 years. He has won scientific renown by his numerous works in various branches of chemistry, especially for his work on catalysis in organic chemistry, and in particular for his method of hydrogenation by finely-divided metals, a discovery which won for him, in 1912, the Nobel Prize for Chemistry, and which is now the basis of many industrial processes.

In 1901 he was appointed a corresponding member of the Académie des Sciences, and was elected a titular member in 1913. He is a member of the Royal Society, London, who awarded him the Davy Medal, and a Grand Officier of the Legion of Honour.

For many years the activity of nickel in chemical reactions was not given much attention. It has only a fair affinity for oxygen, lower than that of cobalt, iron, zinc and manganese and even more inferior to that of magnesium and calcium. About 40 years ago, however, the specific character of this activity manifested itself by the direct combination of the metal with carbon monoxide, *resulting in the formation of a well-defined* volatile compound—nickel carbonyl.† Iron forms a similar compound, although less readily, while carbonyls have since been obtained also from cobalt and molybdenum. This fixation on a metal of a gaseous molecule with free valences, such as carbon monoxide, naturally incited chemists to try and produce similar compounds from other incomplete gaseous molecules, such as nitrous oxide, nitric oxide, nitrogen peroxide, acetylene and ethylene.

In the course of the work which I carried out on this subject with M. Senderens in 1894, by using finely divided metals ob-

* From the *Revue du Nickel*, Jan., 1932, pp. 18-20.

† Mond, Langer and Quincke, 1890.

tained by the reduction of their oxides, we were *able to obtain from nitrous oxide and* nitric oxide only a slight oxidation of the metal with liberation of nitrogen. Nitrogen peroxide, however, directed as a gas on to reduced nickel, gives a bright incandescence which leads to the formation of black oxide. If, on the other hand, its vapour is diluted *with an excess of nitrogen, a regular fixa*tion will be observed which may amount to a quarter of a molecule of NO_2 per atom of nickel, and a solid black unstable product, nickel nitrate, is formed, similar to the metal nitrates derived from cobalt, iron, and especially copper, under the same con*ditions.*

A little later, in 1896, Moissan and Moureu experimented with acetylene. This gas, directed on to nickel, cobalt or iron, freshly reduced from their oxides and cooled to ordinary temperature, gives rise to an immediate incandescence, resulting in the total *decomposition of the acetylene.* The two scientists attributed the cause of this to the heat released by physical condensation in the pores of the reduced metal, it being presumed that the heat produced by the breaking down of the acetylene, an endothermic compound, into its elements carbon and *hydrogen, sufficed to sustain the incandes*cence and maintain the reaction.

In 1897, Mr. Senderens and I obtained a similar phenomenon of destructive incandescence by means of ethylene in reaction with nickel heated to 300° C. The ethylene is decomposed, giving a finely divided black *carbide in which the metal is diffused in* extremely fine particles. The gas given off, however, consists not of hydrogen, more or less contaminated with products arising from irregular heating, but mainly of ethane, and we concluded from this that the nickel, having broken up part of the ethylene, *had utilised the hydrogen formed to* hydrogenate the rest of the ethylene. Iron and cobalt behave in a similar manner, but give a lower proportion of ethane. The phenomenon is most striking with nickel, thus revealing the catalytic properties of this metal.

In effect, a mixture of equal volumes of ethylene (C_2H_4) and hydrogen, acting on reduced nickel at about 40° C., will change into ethane (C_2H_6) with evolution of heat, and the reaction will proceed indefinitely, *without the nickel itself changing in any way.* At 180° C. the reaction is identical in character but much more rapid, and permits of the entire transformation of a rapid current of the gaseous mixture. We have proved that the *same reactions take place* with all ethylene carbides, which are changed entirely into methane carbides.

We consider that this effect is due to the formation, on the surface of each grain of reduced nickel, by direct combination with hydrogen, of a hydride such as NiH_2, an unstable hydride, *capable of rapidly decom*posing into atomic hydrogen, and of thus producing, on the various molecules with which it comes into contact, direct hydrogenation which molecular hydrogen would be unable to produce, or would produce only very slowly. As the regenerated metal is able to combine with hydrogen afresh, the same processes are reproduced indefinitely.

With M. Senderens, and afterwards with MM. Mailhe, Murat, Espil and others, I set out to develop the applications of this hydrogenation capacity. With very few exceptions, all the gaseous molecules capable of combining with hydrogen by addition, or of reacting with it by reduction, reacted more or less quickly, and without any appreciable disturbance, at temperatures not exceeding 180° C., in the presence of hydrogen and nickel recently reduced from its oxide, and with liquid substances the same is true, provided that the pulverulent nickel, the reducible matter and the hydrogen are maintained in intimate contact by adequate agitation.

The catalytic activity of the metal continues *indefinitely* provided there is no trace, either in the material treated or in the hydrogen, of poisonous substances capable of chemically changing the surface of the particles of nickel. Compounds of chlorine, bromine, iodine and sulphur have a somewhat serious effect, since the *chloride*, bromide, iodide and *sulphide* of nickel formed on the snrface of the metal are not reducible by hydrogen at the low temperature of operation. Traces of oxygen or air, on the contrary, are without any harmful effect, the nickel oxide being reduced at 180° C.

It should be added that *in most cases* deterioration of the nickel can be prevented or diminished by insertion, prior to the use of the nickel catalyst, of a reduced copper catalyst (heated to about 250° C.) capable of arresting most of the harmful impurities.

Direct hydrogenation of organic matter

by hydrogen in the presence of nickel has advantageously replaced the old methods, such as sodium or sodium amalgam in contact with water or alcohol, and zinc or iron in contact with dilute acids. Examples which may be given are the transformation of aldehydes into primary alcohols, of acetones iuto secondary alcohols, which take place without any parasitic formation, and also the production of amines from derived nitrates, amides, oximes and nitrites. An even more striking example is presented by the saturation of double ethylene compound, which takes place on a nickel catalyst with extraordinary ease.

The most successful application of the nickel catalyst, however, is in the direct hydrogenation of the aromatic nucleus and of the more complex nuclei of naphthalene, anthracene, etc., a process in comparison with which the old methods are practically worthless. The universal method of hydrogenation by heating in a sealed tube with a concentrated solution of hydriodic acid, a very powerful method, but difficult and dangerous to apply practically, gives only a misleading result with benzene, the hexagonal cycle passing to the pentagonal nucleus. On the contrary, the nickel method applied to benzene and to various aromatic compounds, carbides, phenols, amines, ethers and oxides, changes them easily into cyclohexaue and derivatives of cyclohexane, and the preparation of these latter compounds, which was formerly attended with many difficulties, has now become a very simple industrial operation.

Reference may also be made to the transformationof carbon mouoxide or carbon dioxide into methane, a reaction which can easily be industrialised and which provides the means for replacing water gas of low calorific power by a gas of high calorific power.

The transformation of oils into solid fats by direct hydrogenation in contact with a nickel catalyst is currently in operation in a large number of works, the pulverulent metal being immersed in oil at about 180° C. and violently agitated with hydrogen. Experience has shown the advisability of adding to the nickel a certain amount of copper, which appears to activate it in some way.

Hydrogenation of acetylene by means of an equal volume of hydrogen is very easily produced by nickel at and above ordinary temperatures, and the ethylene thus formed may serve as the basis of the synthetic manufacture of ethyl alcohol.

If the power of nickel as a catalyst is derived, as has been stated above, from the temporary formation of a hydride produced by the direct action of gaseous hydrogen, this same unstable hydride might undoubtedly be formed, under certain conditions, from substances rich in hydrogen, which will thus be dehydrogenated. Finely divided nickel may therefore be presumed to act as a dehydrogenation catalyst, and this activity has been proved by experience in a large number of cases. In the presence of nickel, at fairly low temperatures, the primary alcohols are resolved into hydrogen and aldehydes, and the secondary alcohols into hydrogen and acetones; the hydrocyclic carbides return to the original cycle. In the same way cyclohexane regenerates benzene; limonene furnishes cymene; piperidine returns to pyridine.

Variations of pressure may play an important part in these different catalytic reactions; hydrogenations consisting of a condensation and diminution of the number of molecules are greatly facilitated and accelerated by high pressures, while de-hydrogenations are assisted by a lowering of the pressure.

Another catalytic effect of finely divided nickel arises from its special affiuity for carbon monoxide and from the instability of nickel carbonyl, which is formed by their combination. With M. Senderens, I have shown that from temperatures of 230° C., carbon monoxide is broken down by nickel into carbon and carbon dioxide, at first only partially, then completely at temperatures above 250° C., the nickel remaining diffused in the carbon powder which is deposited; consequently the gases produced by the action of nickel on water gas above this temperature cannot possibly contain the smallest amount of carbon monoxide.

Cobalt, iron, and even copper possess similar catalytic properties of hydrogenation and dehydrogenation, but in these metals the properties are less regular and less active. The superiority of nickel as a catalyst is indisputable, and provided that poisons capable of altering the surface of the grains of metal are carefully removed from the hydrogen or materials upon which it acts, the life of the nickel catalyst is almost indefinite, for all operations carried out at temperatures in the region of 180° C.

Nickel Catalysts in the Hydrogenation of Oils[1]

Certain classes of organic compounds may be caused to combine with hydrogen, when *treated in the liquid or gaseous condition* with gaseous hydrogen in the presence of certain finely-divided reduced metals, known as catalysts, under appropriate conditions of temperature and pressure. Among the metals in question, which act as catalysts, are platinum, palladium, nickel, cobalt and copper, but nickel is by far the most commonly employed in industrial work.

The process whereby this combination is effected is known as hydrogenation, and is *the means by which liquid oils are converted* into solid fats.

Solid fats are of economic value in the production of edible products such as margarine and lard substitutes, and non-edible products such as soap and candles, the quantities required for these purposes being, in the aggregate, much greater than those of the liquid fats of fatty oils, whose main outlets, in addition to soap, are for paints, lubricants, burning oils, leather-dressing, etc. *Liquid fats, however, preponderate in* nature over those which are solid at ordinary temperature, and the latter accordingly tend to be more valuable and possess a higher market value.

It should be mentioned that three classes of oil occur naturally, namely—animal, vegetable and mineral, all of which contain as a base, the elements carbon (C), hydrogen (H), and oxygen (O). In connection with the hydrogenation or "hardening" *process, however, only the animal and vege*table groups are of importance. Although they consist of the same three primary elements in varying proportions, they differ from mineral oils in constitution inasmuch as the former groups yield fatty acids and glycerine, or in other words vegetable and animal oils are made up of compounds of fatty acids with glycerine, which are called glycerides. All fats used in the preparation of edible and non-edible products fall *into this category.*

One of the largest constituents of the liquid oils used for fat-hardening is olein, the glyceride of oleic acid, which is converted into a solid product known as stearin, *the glyceride of stearic acid. Reference to* the formulæ of these two (oleic acid—$C_{18}H_{34}O_2$; stearic acid—$C_{18}H_{36}O_2$) shows the change which takes place in the actual process. The difference between the two substauces is simply that stearic acid contains two more atoms of hydrogen than oleic acid; hence the object of the whole process is to add the two atoms necessary to accomplish the transformation.

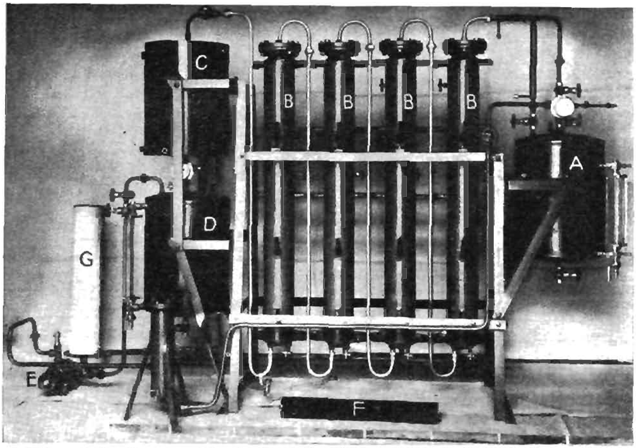
Although olein is the main constituent of *most natural oils, the products of animal* and vegetable origin are really very complex mixtures, and contain, in addition to olein, numerous other glycerides, related to it in chemical constitution, some of which require more than two atoms of hydrogen for conversion into stearin.

Attempts were made for many years to find a means of carrying out what is now so easily accomplished by the hardening process, using nickel as a catalyst, for it has *long been evident that oleic acid and its* glyceride olein occur abundantly in liquid oils such as cotton, linseed, soya-bean, rape, *whale, herring, seal oil, etc.,* while there was a definite shortage of the solid fat stearing the basis of nearly every edible and non-edible fat.

In the course if his classic work on the catalytic hydrogenation of the vapours of organic compounds in the presence of nickel, Sabatier observed that oleic acid was thus transformed into stearic acid, but he believed that hydrogenation only occurred in the state of vapour. In 1902, however, *Normann found that reduced nickel oxide* when suspended in fatty acids or fatty oils in the presence of hydrogen, effected hydrogenation in the liquid state. This discovery, which may be looked upon as the foundation of technical fat-hardening, was developed in the course of the next decade into a process suitable for large-scale working, and by about 1910 the output of hydrogented fats probably amounted to several hundred tons per week.* The war gave an *immense stimulus to the industry, for with-*

[1] Published by courtesy of the Mond Nickel Company, Ltd., who also supplied the blocks to illustrate this article.

* T. P. Hilditch, "Catalytic Processes in Applied Chemistry," 1929.



Small Four-Tube Plant used in the Technical Research Works Ltd. Continuous Process.

A. *Feed Vessel.*
B. *Hydrogenation Tubes.*
C. *Cooling Coil.*
D. *Receiver.*
E. *Hydrogen Circulating Pump.*
F. *Cage of Catalyst.*
G. *Activating Vessel.*

out it a serious shortage of soap, candles, margarine and lard substitutes would no doubt have resulted; capacity was rapidly extended, and in 1918, the world's potential output of hardened fats had reached many thousands of tons per week. Since that time the demand for hardened fat has somewhat declined, but the industry is nevertheless firmly established on a large scale; it helps to keep a balance between the costs of soft and hard fats, while as the prejudices against hardened products have died away, it is very probable that the use of hydrogenated fats will increase rather than diminish.

Were it not for the discovery and commercial application of hydrogenation, the great whale oil industry, with its immense floating factories, could not have reached its present magnitude. By no other known commercial process can the fishy smell be removed so as to render the oil suitable for soap and edible purposes.

The original process of hydrogenation devised by Normann, together with important later modifications, has now merged into the general title of the "powder process," in which the catalyst is prepared by reducing nickel carbonate in hydrogen at a temperature of 300°-350° C., the pyrophoric powder so obtained being added to the oil to be hydrogenated.

Modern methods may be divided into (1) batch processes and (2) continuous processes, although in some cases there is no clear line of demarcation between the two.†

In the majority of batch processes, the use of powder catalysts, with or without supports, is involved, and in such cases the rapidity and economy of the process depend upon the degree of contact of the phases involved, namely, a gas (hydrogen), a liquid (oil), and a solid (catalyst). Various inventions have been recorded in order to increase such contact; these may be classified broadly into (1) agitation systems, in which mechanical agitation is used to

† E. R. Bolton, *Jnl. Socy. Chem. Ind.*, 1927, vol. 46, pp. 444T-456T.

produce an intimate mixing of the nickel, fatty acid and hydrogen and (2) circulation processes, in which a mixture of oil and catalyst is withdrawn from the lower part of the reaction vessel, and injected under pressure as a fine spray into the gas-space at the top of the vessel.

The continuous process was developed considerably later than the others, and appears to offer several advantages over the earlier methods, since it has been proved that the preparation, regeneration, and efficiency of the stationary catalyst are technically satisfactory. The following brief description relates to the continuous process of Technical Research Works, Ltd., developed by Bolton and Lush, which introduces an entirely novel principle in the reactivation by anodic oxidation of the spent catalyst. The catalyst used in the process is in compact form and consists of a mass of oxidised nickel turnings, wool or wire contained in an openwork nickel frame, as shown in the illustration on page 183. The surface of the nickel is rendered catalytic, either by immersing it as the anode in a dilute solution of sodium carbonate which is electrolysed at a suitable current density, or by steeping it in a bath of dilute sodium hypochlorite of definite concentration. The metal thus receives, by either process, a superficial coating of an adherent film of oxide which yields an active catalyst when, after washing and drying, it is replaced in the hydrogenation tubes and exposed to the action of hydrogen at about 250° C.

A stream of oil and hydrogen is passed over the catalyst contained in a number of tubes in series, and the hydrogenated oil thus produced leaves the plant in a clear and bright condition, requiring no filtration. The time of contact of the oil with the nickel catalyst is only a few minutes—a very real advantage over the "powder" process in which the contact is considerably prolonged. The control of the process is simple and any desired degree of hydrogenation of the oil can be obtained by adjusting the rate of flow of the oil through the plant, which is self-contained and inexpensive as the catalyst is practically permanent, and easily and cheaply revivified by anodic oxidation when necessary.§

It is claimed that a unit hardening only 5 tons of oil a week will pay, but the process is in commercial operation in much larger units than this, standard units of 100 tons per week being in use, and multiples of these are manageable at a low increase of overhead charges.

The photograph on page 181 shows a small four-tube works-scale plant, having an output of about 5 tons per week. The large vessel on the right is the reservoir for the oil to be treated, the oil being forced by hydrogen pressure through the exit on top. After passing through a sight gauge, it is met by a stream of hydrogen which mingles with it in its passage up and down through the four vertical reaction vessels and thence into a separator on the left, from which the hydrogenated oil passes, by gravity, to a cooling coil, and is collected ready for use. The hydrogen is returned into the system from the separator, through a trap, by means of a pump.

One of the cartridge-like cages which contain the nickel catalyst may be seen in front of the apparatus (see also the illustration on page 183).

The large factory models, being similar in design, are of equal simplicity, and require the minimum of attention once the continuous flow has been set.

The advantages claimed for this process are as follows :—*

(1) Continuous operation.

(2) The hydrogenated oil flows from the apparatus in a clear and bright condition, and needs no filtration.

(3) The catalyst may be regarded as part of the plant, and can be revivified, by anodic oxidation and subsequent reduction, for years without any appreciable loss.

(4) Control of composition of the hydrogenated product (selection).

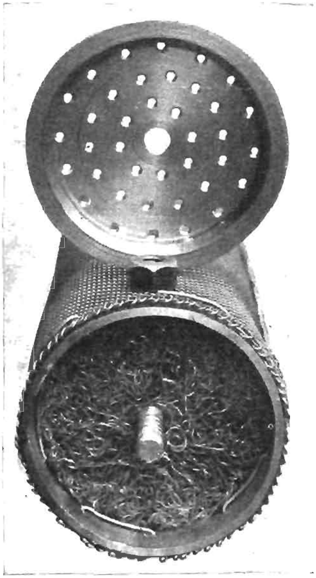
(5) The output of the plant is inversely proportional to the extent of hydrogenation.**

(6) There is no "splitting" of the oil, with formation of free fatty acids; consequently, subsequent neutralisation by alkali is not necessary.

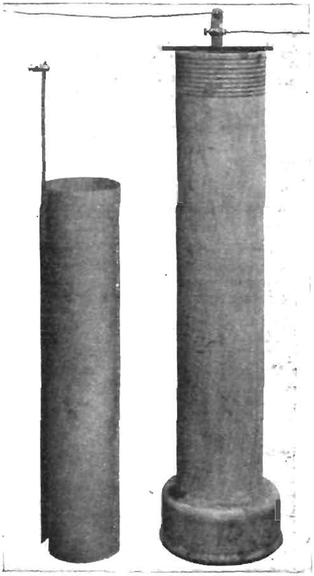
§ E. F. Armstrong, *Chemistry and Industry*, 1932, vol. 51, p. 92.

* E. R. Bolton, "Oils, Fats and Fatty Foods," 1927.

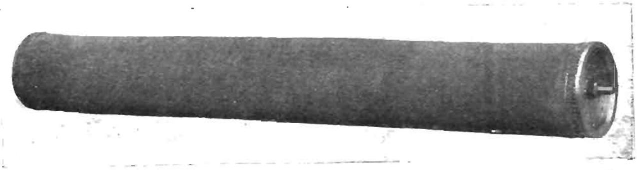
**E. J. Lush, *Jnl. Socy. Chem. Ind.*, 1924, vol. 43, p. 53T.



End View of Cage, showing Nickel Turnings.



Apparatus for Reactivating Spent Catalyst Cage.



The Nickel Catalyst in the Bolton and Lush Continuous Process is contained in Open-work Nickel Cages ranging from 2 to 5 ft. in length, and from 4 to 12 ins. in diameter.

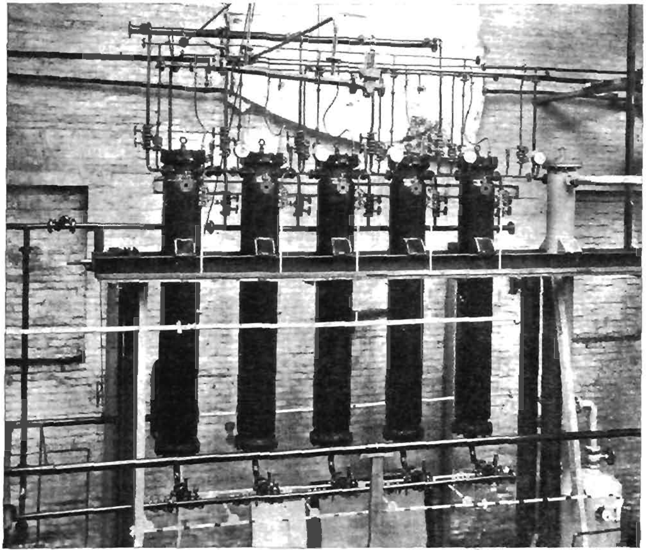
(7) The oil is heated for about 10-15 minutes only during the operation of hydrogenation.

(8) Low cost of operation.

An average figure for hydrogen consumption over the range of oils dealt with in a fat-hardening installation is about 1 per cent. by weight of the fatty oil treated, or about 3,000 cubic feet of hydrogen per ton *of oil, but the actual amount of hydrogen* with which different fats combine is, of course, dependent on their original state of unsaturation and on whether they are to be *converted into hard tallow-like fat, soft fat, or semi-liquid fatty oils.*

The three principal methods of hydrogen manufacture are the electrolytic, steam-iron and water gas catalytic processes, electrolytic hydrogen being purer and cheaper to produce in small quantities, while oxygen is obtained as a by-product.

In conclusion it should be mentioned that *the Bolton and Lush continuous process is* particularly suitable for the hydrogenation of chemicals, some of which are dangerous to handle, such as phenol; others require strict temperature control, such as aldehydes; *while others are sensitive to unreduced* nickel oxide, such as furfural. Phenol, cresol, naphthalene, pyridine and crotonaldehyde are being hydrogenated on *a commercial scale. In each of these cases a film of reduced nickel oxide on a nickel* surface, used in a continuous process approaches the ideal of simplicity, certainty and safety.



[By courtesy of Technical Research Works, Ltd.

A Moderate Size Hydrogenation Plant in operation in India for the Production of Vegetable Ghee. In this plant there are five reaction tubes each containing two 12 in. cages.

SCIENCE IN THE VARNISH WORKS.

By Louis Light, Ph.D.(Zurich), A.I.C.

Mention of varnish manufacture irresistibly conjures up a vision of a perspiring workman stirring a sooty pot over a smoky fire, the whole being slightly reminiscent of the concoction of home-made jam. But that's varnish making—that was!

Whilst it cannot be doubted that paints and enamels of wonderful durability have been turned out in the past by the method of empirical cookery—or perhaps in spite of it—the rigorous scientific control which is now being rapidly adopted by this important British industry is a happy portent of a new standard of quality. Resins and oils, the two indispensable ingredients of oil varnishes, are gradually yielding up the mysteries of their composition to the scientist, and the power which springs from this newly-acquired knowledge is introducing a high degree of mathematical accuracy into an age-old craft. The old time varnish boiler was, indeed, a craftsman. And if first class work can never be entirely independent of first class workers, the day is gone for ever when success in the manipulation of resins and oils of unknown composition could only be gained by years of experience in the varnish kitchen.

When inexplicable failure to turn out a good batch of material exasperated the varnish cooker of the past, he must have felt himself baffled by some fundamental intricacy in his raw materials. The scientific varnish chemist of to-day knows something about this intricacy, probably only just enough to make him realise how little he really does know. But this knowledge is growing and teaching him to approach varnish materials such as linseed oil with the respect which they deserve. And this conclusion which is now being translated into practice is that consistently successful varnish manufacture demands mathematically precise control equal to that exercised in any other industrial chemical process.

So the curtain rings down on the smoke-laden varnish kitchen with its rusty iron cauldrons stirred by perspiring cooks, and rises on the perfectly ventilated chemical factory in which the ingredients are worked up in glistening, huge aluminium pots, heated conveniently and economically by gas, fitted with electrically operated stirring gear and suction fume-withdrawal fans. The temperature is controlled with the same care as in the case of a feverish patient and all materials are chemically analysed before charging into the pot. In this latter connection, the many specifications on varnish components issued by the British Standards Institution give an insight into the indispensable role here played by analytical chemistry. The net result of systematic manipulation reinforced by exact knowledge of the chemical nature of the ingredients is the production of uniform varnishes with almost clockwork regularity.

If long articles could be written—as indeed they have been—about the peculiarities of varnish oils such as linseed oil and china wood oil, whole books are needed to deal with the eccentricities of the resins, including the hard copals which were formerly indispensable in the best varnishes. But here again, a new era is being inaugurated, for the chemist is now able to produce resins of a more or less synthetic character and well able to bear comparison with the best of nature's handiwork. In some respects, indeed, the new artificial resins are vastly superior, being paler in colour, more resistant to the destructive action of moisture and sunlight, and are furthermore obtainable in perfectly uniform qualities. It is pleasing to be able to record that a substantial share of the credit for this pioneer work must be awarded to Imperial Chemical Industries Ltd., whose new synthetic varnish ingredients possess remarkable qualities and promise to make history in the technique of protective and decorative coatings.

RUBBER LINED PUMPS.

An Interesting Development for the Chemical Industries.

By A Well Known Engineer.

For the pumping of acid, corrosive, and difficult liquids containing fibrous material and all kinds of non-abrasive solids, extremely valuable is the latest design of the "Flexala" pump. Like the "Stererophagus" pump this is the invention of the Hon. R. C. Parsons, brother of the late Sir

Charles Parsons of steam turbine fame, and is manufactured by the Pulsometer Engineering Company of Reading.

Essentially the design is that of an ordinary centrifugal pump, but with the important feature that the impeller is covered with specially tough rubber. In a modified type, the cover as well as the impeller is lined in this way, while in another development, known as the " Resiline " pump, the whole of the interior of the casing is protected on these lines.

The subject is of course particularly interesting from the chemical point of view and it is well known that rubber is a peculiarly resilient and resistent material. For example a prominent rubber firm in Manchester laid down a pavement in front of their offices well over half a century ago, and this is still in perfect condition, *although stone, concrete*, or metal would long since have been worn out. Similarly, the " Resiline " pump has run continuously for comparatively lengthy periods pumping a mixture of water and extremely hard and abrasive sand of such character that impellers and liners of manganese steel or chilled white iron would have had a very short life.

The serious erosion of induced draught fan casings because of the high water gauges now being demanded in super-power station practice, such as 10-12" or even over, is another example of the manner in which steel, and hard metal generally, is easily affected. In this case the velocity of the gases is so high that the large amount of dust present, generally varying within the range of 0.25-10 per cent. by weight of the total coal burnt, and in some cases as high as 15 per cent. sets up an actual sand blast action. Rubber, however, in remarkable fashion is little affected by erosion at ordinary atmospheric temperatures, whilst rubber line decntrifugal pumps are unaffected by almost every class of acid and corrosive liquid, being particularly suitable for the chemical and allied industries.

In the past difficulties have been experienced in finding a satisfactory method of attaching rubber to cast iron, gunmetal, or other metals, but these have been gradually overcome, representing a great advance in the field of pumping under high speed conditions, with resultant small capital cost, weight, and floor space for unit duty.

WHAT THE ARABIAN PHYSICIAN SAID ABOUT DIET AND WHAT HE MIGHT HAVE SAID.

The mention of diet to-day makes all ears prick up. But the subject is by no means as modern as some might think. For example, when Dr. Ogden, in the course of his lecture on " Nutrition from the Viewpoint of the Physiologist "[1] gave to his hearers a neat little aphorism on food intake, I was reminded of something recorded by Sa'di, the Persian poet-philosopher, back in the thirteenth century.

Dr. Ogden said : " What can not profitably be used can not profitably be eaten."

Sa'di said :[2]" It is written in the annals of Ardeshir Babekan (the first King of the Sasanian dynasty. He reigned from A.D. 226-240) that he asked an Arabian physician how much food ought to be taken daily. He answered : ' The weight of one hundred dirrhems were enough.' The king asked him : ' What strength will this quantity give me ?' He replied : ' *This quantity will carry thee; but whatever more is taken, thou wilt be the carrier of it !*' "

My big dictionary does not show the value of the dirrhem even amongst the scores of strange weights defined. But the Arabian physician, if he were with us to-day, might have made this modern answer : " O King ! Eat no more than three thousand calories each day, properly balanced for amino-acids, carbohydrates, fats, mineral salts, and vitamins ! For surely if you grossly exceed this average without a proportionate increase in energy expenditure, you will have to go on the Hollywood diet, or else be overtaken by a right royal spare tyre around your middle, and double, triple, or even quadruple chins !"

LOREN B. TABER, B.Sc. D.D.S.

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[1] Univ. of Calif. Extension Division, Lectures on Metabolism, Nutrition, and Diet, Sept., 1931.

[2] The Rose-Garden of Sa'di, by L. Craumer-Bying. E. P. Dutton and Co. 1909. Page 39.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

March 3.

The following papers were read : –

The Phenomena of Superconductivity with Alternating Currents of High Frequency. By J. C. McLennan, F.R.S., A. C. Burton, A. Pitt and J. O. Wilhelm.

In the experiments described in this paper it was found that with currents of frequency 1.1×10^7 per second a coil of lead wire shewed an abrupt loss of resistance, of relatively large amount, at a temperature that appeared to be slightly lower than the critical temperature 7.2°K characteristic of the transition to superconductivity, found for the same wire with direct current.

In a series of repeated experiments with a coil of tin wire, drawn to a diameter of 0.3 mm., it was found that with direct currents the resistance of the coil began to decrease abruptly at 3.76°K and disappeared completely at 3.70°K. Experiments with the same coil with currents of frequency 1.1×10^7 per second gave for the corresponding temperatures 3.67°K and 3.61°K. *i.e.*, superconductivity did not begin to appear until a temperature was reached that was below the one at which it was complete in the case of the direct current experiments. Further experiments with higher frequncies revealed depressions of the critical transition temperature increasing in amount with the frequency. Extrapolation of the transition temperature-frequency curve, which appeared to be linear for the higher frequencies, gave 10^9 per second for the frequency corresponding to 0°K.

With tantalum wires results were obtained similar in character to those found with wires of tin and lead. Experiments with tin wire coils shewed that the observed depression of the critical temperature was not dependent upon the magnitude of the high frequency currents in the coils and was therefore attributable neither to the heating of the coils above the surrounding liqnid helium, nor to the effect of the magnetic field of the currents. Experiments with wires of different sizes made with currents of the same frequency shewed that the depression of the transition temperature was not a direct function of the skin effect. It would appear then to be a function of the frequency of the current in the metal alone.

The conclusion is drawn that polarisation and orientation phenomena are involved in the production of the superconducting state in metals. This electrical state, it is pointed out, *appears in part at least to be somewhat* analogous to the saturated magnetic state obtainable with ferromagnetic metals.

The Transport of Vorticity and Heat through Fluids in Turbulent Motion. By G. I. Taylor, F.R.S.

The theory that the dynamics of turbulent motion should be regarded as an effect of diffusion of vorticity rather than as a diffusion of momentum was put forward by the present writer in 1916 and the particular case when the whole motion is limited to two dimensions was then discussed though so briefly that it appears to have escaped notice. The analysis is now extended to three-dimensional motion and it is shown that the "momentum transport" theory of Reynolds and Prandtl agrees with the "vorticity transport" theory in one case only, namely when the turbulent motion is of a two-dimensional type, being confined to the plane perpendicular to the mean motion.

When the turbulent motion as well as the mean motion is confined to two dimensions the vorticity transport theory yields results which are quite different from those predicted by the momentum transport theory.

A searching test of the comparative merits of the two theories is provided by comparing the distribution of temperature and velocity in the wake behind a heated obstacle. According to the momentum transport theory they should be identical, at any rate at some distance down stream, while according to the vorticity transport theory they should be related to one another by an equation which is given. Measurements made at the National Physical Laboratory show a large difference between the distributions of temperature and velocity and confirm the accuracy of the theoretical distributions given by the vorticity transport theory for the case of two-dimensional motion when the turbulent motion is confined to the plane of the mean motion.

An Examination of Turbulent Flow with an Ultramicroscope. By A. Fage and H. C. H. Townend. Communicated by G. I. Taylor, F.R.S.

Turbulent flow in pipes has been examined with an ultramicroscope. Minute particles present in tap water were intensely

illuminated and viewed against a dark background. These particles were small enough to show the Brownian movement when the fluid was at rest.

The illuminated particles were used to follow the motion of the fluid, and enabled the maximum values u_1, v_1 and w_1, of the three components, u, v, and w, of the velocity disturbance at any point to be measured. The distribution of the mean velocity U across the pipe was obtained by the same means, so that all the obserbations were made witrout introducing any instruments into the fluid.

Most of the observations were taken in a square pipe and a few in a circular pipe. The results were of the same character in both pipes.

At the centre of the pipe all three components, u_1, v_1 and w_1, were approximately equal. As the wall was approached the ratio v_1/U obtained from the velocity disturbance normal to the wall decreases to zero, whilst the other two ratios u_1/U and w_1/U increased. At the wall itself, it was found that whilst the flow tended to the luminar type the motions of particles in the laminæ were sinuous, even to within a distance of 1/40,000 inch from the wall. No particle was seen to move in a rectilinear path.

As the speed of flow was increased through the critical range of Reynolds number, the changes of flow occurred with great suddenness. There was no sign of a growth in the *degree* of turbulence, hut only a change in the relative frequency and duration of the periods of rectilinear and turbulent flow.

SOCIETY OF PUBLIC ANALYSTS.

The Aunual General Meeting of the Society was held on March 4, when the President, Dr. J. T. Dunn, delivered his Presidential Address.

The following were elected as Officers and Council for the year 1932 :—

President : F. W. F. Arnaud. *Past Presidents serving on the Council* : E. Richards Bolton, A. Chaston Chapman, J. T. Dunn, Bernard Dyer, Edward Hinks, P. A. Ellis Richards, G. Rudd Thompson, J. Augustus Voelcker. *Vice-Presidents* : H. M. Mason, G. W. Monier-Williams, G. Stubbs. *Hon. Treasurer* : E. B. Hughes. *Hon. Secretary* : G. Roche Lynch. *Other Members of Council* : A. L. Bacharach, H. E. Cox, E. M. Hawkins, A. E. Johnson, W. G. Messenger, H. H. Bagnall, W. T. Burgess, G. D. Elsdon, John Evans, L. Eynon, J. R. Nicholls.

The Society of Public Analysts and Other Analytical Chemists held a Dinner at the Trocadero Restaurant on March 4th, to celebrate the 56th anniversary of the foundation of the Society.

The Members and their guests, numbering over 100, were received by the Past President, Dr. J. T. Dunn, F.I.C., and Mrs. Dunn, and Dr. Dunn afterwards took the chair at the Dinuer.

The guests of the Society included the Rt. Hon. Lord Atkin, P.C., D.C.L. (Lord of Appeal), Councillor J. G. Nixon, J.P. (Lord Mayor of Newcastle-upon-Tyne), Sir Ernley Blackwell, K.B.E. (Assistant Under-Secretary, Home Ofice). Mr. A. T. A. Dobson, C.V.O., C.B.E. (Assistant Secretary, Ministry of Agriculture and Fisheries), Sir F. Gowland Hopkins, D.Sc., F.I.C., F.R.S. (President of the Royal Society), Professor G. T. Morgan, O.B.E., D.Sc., F.I.C., A.R.C.S., F.R.S. (President of the Society of Chemical Industry), Mr. Percy Gates (President of the Institute of Brewing), Mr. George Gray, M.Sc., F.I.C., M.I.Chem.E. (Vice-President of the Institution of Chemical Engineers), Sir Ernest Graham-Little, M.P., Mr. Norman Kendal, C.B.E. (Assistant Commissioner of Police), Mr. A. W. Monro, C.B. (Ministry of Agriculture and Fisheries), and Mr. R. B. Pilcher, O.B.E. (Registrar, Institute of Chemistry).

After the toasts of H.M. the King and the Members of the Royal Family had been honoured, the President proposed the bealth of the Members of H.M. Civil Service. Dr. Dunn emphasised the harmonious relations which existed between those branches of the Civil Service wbich were intimately associated with the work of Public Analysts and Agricultural Aualysts, and he described H.M. Civil Service as one of the great causes of the stability of this country and as the object of envy and respect of other nations.

Sir Ernley Blackwell, replying to the toast, referred to the connection between the Home Office and the Society, and said that it was almost fifty years since the first two Official Analysts to the Home Office were appointed. He recalled the fact that one of the most distinguished of these

analysts was the late Sir Thomas Stevenson, a former President of the Society. He pointed out that the evidence in Court that was based on the facts provided by analysis was, as a rule, accepted by both sides, though the inferences to be drawn from those facts were sometimes challenged.

Mr. A. T. A. Dobson also replied to the toast, and referred to the harmonious relations existing between the Ministry of Agriculture and the Society of Public Analysts. He said that cases in which permission to prosecute was given by the Ministry of Agriculture were seldom the outcome of deliberate fraud. He expressed the hope that farmers would in the future avail themselves even more than in the past of the facilities provided by the new Act to have their fertilisers and feedings stuffs examined by the Official Agricultural Analysts, in order to ensure that their supplies were of the required standard and that they were receiving value for their money.

Lord Atkin, in proposing the health of the Society, spoke of the value of the services of Public Analysts to the community, and contrasted the condition of the purity of food at the present time with that which was prevalent before the passing of the first Food and Drugs Act. He expressed the view that definite standards should be fixed for foods, and in particular for milk, and that the onus should be upon the vendor to prove that the article sold conformed to that standard. The fact that vendors could defy the recognised standard for milk with an explanation about the idiosyncracies of the cow was due, not to legislation, but to a decision of three out of five judges in a certain criminal case. He had always longed for the time when an enterprising municipal authority would really fight this cause in a civil case, and take it, if necessary, through the Court of Appeal to the House of Lords for the benefit of the community. It would bring great advantage to the public if that former decision could be altered.

The toast was responded to by the President.

The health of the Kindred Societies was proposed by Mr. A. Chaston Chapman, who pointed out how the various scientific societies, and particularly those connected with chemistry, were becoming more closely associated, owing to the way in which their work tended to overlap. Although he regarded this as a step in the right direction, he was personally of the opinion that each Society should retain its individual entity.

Sir F. Gowland Hopkins, replying for the Kindred Soceties, paid a tribute to the usefulness of the journal of the Society of Public Analysts (*The Analyst*) to workers in biochemical laboratories.

Mr. E. Hinks proposed the health of the numerous guests, the toast being acknowledged by the Lord Mayor of Newcastle and Mr. George Gray.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Proceedings at Monthly Council, March 2.

Mr. Fred Smith (Chairman) reported that Dr. Voelcker had drawn attention to a case recently heard before the High Court in which the death of six horses and illness of twenty-two others had been occasioned by the presence of castor-oil bean in a cargo of maize shipped from South Africa. The issue was tried on other grounds than the loss of and injury to the horses, this being admitted and £430 having been paid as compensation. It was interesting, however, to note how this came about. It appeared that in a cargo of 3,584 bags of maize loaded at Mombassa there were seventy-nine bags of loose collected cargo, which included the sweepings of the floors. The purchasers took fifteen of the seventy-nine bags and sent them on to a firm of forage merchants, who mixed it with other grain and sold a parcel to a cnstomer. The latter, on feeding his horses with it, experienced the losses stated.

In the course of the hearing it came out that the maize had been loaded in the same hold as other materials, of which castor seed was one, though evidence was given that these were directed to be kept separate from other produce. On discharge of the cargo, however, the floors were swept up and what was gathered was divided between the receivers of the cargo. In this way, no doubt some of the loose castor bean found its way into the fifteen bags sold to the owner of the horses. The firm who purchased the fifteen bags had taken no steps to assure themselves of the freedom of the goods from castor, and, as it was held that they had had notice of castor seed comprising part of the cargo, they were held liable.

The case is important as showing how castor bean may find its way into feeding

stuffs sent from abroad, and also as illustrating the very harmful nature of materials that contain castor even in small amount.

Poultry Manure.—Increased attention is now being given to poultry-keeping; and the conservation of the manure derived, when produced on a sufficiently large scale, is also worthy of consideration. A member of the Society sent Dr. Voelcker two samples of such manure from one and the same load, the one being, however, in the natural, undried state, while the other had been subjected to a process of drying by hot air.

The analytical results were :—

	Undried	Dried
Moisture	21.43	10.86
*Organic Matter and Salts of Ammonia	52.68	61.61
Lime	4.70	5.04
Phosphoric Acid...	4.73	4.85
Alkalies, etc.	6.42	7.29
Sand and Siliceous Matter	10.04	10.34
	100.00	100.00
*Containing		
Total Nitrogen...	3.09	3.21
Equal to Ammonia ...	3.76	3.90

It would be noticed that, though the dried sample had considerably less water, it was but slightly benefited otherwise by the drying. Neither sample had ammonia present to any extent as ammonia salts, but both samples were of good quality and had but little extraneous matter, earth, etc. Peat moss had been used as litter.

Compound Feeding Cake.—A member sent Dr. Voelcker a sample of compound cake, for which be had paid £9 5s. a ton. This, while coming up to the guaranteed analysis given, was found to be made up, for much the greater part, of undecorticated cotton cake, it having also some earthnut cake, and a little locus bean and peas or beans. When one considered, however, that the price of cotton cake at the time was £5 7s. 6d. *ex mill*, it would be seen that, even after allowing for the other ingredients, compounding, carriage, etc., there would remain a considerable margin, and the cake must be considered decidedly dear at £9 5s. per ton.

The Chairman read a letter from the Secretary referring to the need for reduction in expenditure. The Chemical Committee felt that apart from the question of the salary of the Consulting Chemist, the estimated expenditure (£15) was so small tha there seemed no room for any reduction.

Mr. Fred Smith, in moving the adoption of this report, referred to the fact that on many occasions the Chemical Committee had directed attention to the unfortunate results arising from the feeding of castor bean. Only last year the Committee assisted a member in obtaining as damages some £594, where castor bean had been mixed with the cake that he fed to his cattle. Many members had availed themselves of the privilege offered by the Society of sending samples for examination, but it was thought that many who bought compound artificial manures and compound feeding stuffs might with advantage send in samples to be tested, even if only to see that they were not being "done in the eye." (Laughter.) It was not the reliable merchant the Committee found fault with but rather the merchant who employed salesmen at a very large commission to go round and sell compound manures and feeding stuffs which had artificial and flourishing names but were of very little value.

The report was adopted.

ROYAL INSTITUTION.

At a General Meeting of the Members of the Royal Institution, Sir Robert Robertson Treasurer and Vice-President, in the chair Mr. J. W. Alderson, Mr. G. P. V. Aylmer Mrs. G. T. Baldwin, Miss Sheila Beddington, Mrs. Cloudesley-Brereton, Mrs. H Thornton Ellis, Dr. Freidrich Halle, Lady Simson, Mr. A. I. Steven, Miss Mary W Sutton and Mr. W. G. Wilsher were elected Members.

MINERALOGICAL SOCIETY.

Tuesday, March 15.

The following papers were read :—

The Distinction of Pyrite from Marcasite in Nodular Growths. By F. A. Bannister

On the Changed Composition of an Anorthoclase-bearing Rock-glass. By Dr L. Hawkes and Dr. H. F. Harwood.

The Spherulitic Rhyolites of Jersey. By Dr. A. E. Mourant.

An Albitite from Ve Skerries, Shetland Isles. By Dr. F. Walker.

Mr. J. B. Scrivenor exhibited Magnesium borate from the Federated Malay States.

THE NEW PRESIDENT OF THE INSTITUTE OF METALS.

Sir Henry Fowler, K.B.E., LL.D., D.Sc., Wh.Ex., M.Inst.C.E., M.I.Mech.E.

Sir Henry Fowler, who was elected President of the Institute of Metals on March 9, 1932, was born in July, 1871, and educated at Evesham and Mason Science College (now the University of Birmingham).

He served an apprenticeship at the Locomotive Works of the Lancashire and Yorkshire Railway at Horwich, and was for a considerable time engaged in the Test Office there. He conducted classes in engineering and metallurgical subjects at the Mechanics' Institute.

He was prominently connected with the heavy motor-car trials of the Liverpool Self-Propelled Traffic Association, which were the pioneer trials in connection with this class of vehicle.

In 1900 he joined the staff of the Midland Railway Company at Derby, becoming successively Gas Engineer, and Works Manager. In 1910 he became Chief Mechanical Engineer, holding this position until the amalgamation of the railways in 1923, when he became Deputy Chief Mechanical Engineer of the London Midland and Scottish Railway, and in 1925 was appointed Chief Mechanical Engineer of this railway. He was responsible for the design of many of their standard locomotives including the well-known "Royal Scot" class. He was responsible also for the reorganisation of various locomotive repair shops, which has led to a very great reduction in the number of engines under and awaiting repair, and therefore in the amount of stock available. This resulted in a considerable reduction in the 10,000 loco motives which the L.M.S. originally had.

He has read numerous Papers before the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Locomotive Engineers, etc., and quite recently received the distinction of being elected an Honorary Life member of the Institution of Mechanical Engineers. It will also be remembered that he gave the second Autumn Lecture to the Institute of Metals in 1923 on "The Use of Non-Ferrous Metals in Engineering." He has been awarded the Gold Medal of the Institute of Transport for his Paper on "Locomotive Repairs."

He has been President of many bodies, including the Institution of Locomotive Engineers, Institution of Automobile Engineers, Institute of Locomotive Inspectors and Foremen, Section "G" (Engineering) of the British Association for the Advancement of Science, Birmingham University Engineering Society, and the Institution of Mechanical Engineers.

He has had conferred upon him the Honorary Degree of LL.D. by the University of Birmingham, and of D.Sc. by the University of Manchester, and is the first Honorary Graduate of the Manchester College of Technology.

He has been keenly interested in education, and serves on the local education committee, and was a member of the Board of Education Committee on education for the engineering industry.

He has also a keen interest in sport, particularly hockey, and has been President of several local associations and Chairman of the English Selection Committee. He has played for Derbyshire and the Midland Counties, and still is an umpire of the game.

During the war, before the Ministry of Munitions was formed, he was Secretary to the Railway Companies' Munitions Sub-Committee, and upon the formation of the Ministry in June, 1915, was appointed Director of Production; and later Superintendent of the Royal Aircraft Factory at Farnborough. He was also a member of the Advisory Committee on Aeronautics, and Chairman of the Light Alloys Sub-Committee of this body, as well as a number of committees dealing with various aircraft work.

He was a Lieut.-Colonel of the Royal Air Force (T.F.), and is also Lieut.-Colonel of the Railway Engineering Staff Corps (T.F.).

In 1931 Sir Henry relinquished his position as Chief Mechanical Engineer of the L.M.S. Railway on appointment as Assistant to Vice-President for Research and Development.

Forthcoming Events.

SATURDAY, MARCH 19.

International Society of Leather Trades' Chemists. *British Section.* The University, Leeds, at 10 a.m. "Determination of the p_H of Tanning Extracts," by Dr. D. Burton. "Sulphuric Acid in Vege-

table Tanned Leather," by Messrs. Atkin and Thompson. "Absorption of Water by Sole Leather," and "Some Notes on the Wearing Properties of Sole Leather by Means of the Thuau Machine," by Dr. J. G. Parker and A. Harvey.

MONDAY, MARCH 21.

S.C.I. *Yorkshire Section.* Joint meeting with the Leeds Area Section of the Institute of Chemistry. "Photoelectric Cells and their Industrial Applications," by T. M. C. Lance.

INSTITUTE OF CHEMISTRY. *Leeds Area Section.* Joint meeting with the Yorkshire Section of the S.C.I. (See above.)

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by permission of the Controller of H.M. Stationery Office and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., price 1/- weekly (annual subscription, £2 10s.).

5,921.—I. G. Farbenindustrie Akt.-Ges., and Johnson, J. Y. (I. G. Farbenindustrie Akt.-Ges).—Reduction of phenols. Feb. 27.

5,803.—Johnson, J. Y. (I. G. Farbenindustrie Akt.-Ges.)—Manufacture of alpha-aminocarboxylic acids, etc. Feb. 26.

5,519.—Kali-Forschungs-Anstalt Ges. — Recovery of bromine, etc., compound. Feb. 24.

5,232.—Kali-Forschunge-Anstalt Ges. — Production of organic bromine compounds. Feb. 22.

5,357.—Spittle, H. M.—Manufacture of sodium aluminate. Feb. 26.

Specifications Published.

367,381.—Imperial Chemical Industries, Ltd., Crawford, F. A. F., and Challenor, W. A. F.—Contact process for preparing sulphuric acid.

367,60.—Montecatini Soc. Generale Per L'Industria Mineraria ed Agricola. —Production of ammonium nitrate.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

Group Abridgments can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., either sheet by sheet as issued on payment of a subscription of 5s. per Group Volume or in bound volumes, price 2s. each.

361,509.—Recovering waste sulphuric acid. — Frisher, H., 35, Budapesterstrasse, Berlin.

Sulphuric acid is recovered from the waste acid liquors from the refining of oils, fats and the like by concentrating the liquors until they contain, at least 60 per cent., say 60-80 per cent. of sulphuric acid and then diluting them, whereupon organic impurities are precipitated and removed. The waste acid liquors may be treated by diluting with water in the usual way to remove the major portion of the resinous and oleaginous impurities before being subjected to the above treatment. The concentration may take place at temperatures above 100° C. of say between 150° and 190° C. Examples are given.

The Latest Trade Marks

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of His Majesty's Stationery Office.

DOZETTE.

528,779.—Chemical substances used for agricultural or horticultural purposes.—Martha Leggate Brownlie, 9, Kingsland Drive, Cardonald, Glasgow, S.W.2. February 24.

WINRIK.

528,061.—All goods in Class I which includes chemical substances used in manufactures, photography, or philosophical research and anticorrosives.—Herbert Pering Carter, Kennett Hall, Newmarket, Suffolk. March 2.

SHIRLAN.

529,320.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—British Dyestuffs Corporation, Limited, Hexagon House, Blackley, Manchester. March 2.

THE CHEMICAL NEWS

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Status of Hydrogenation of Petroleum, Bitumen, Coal Tar and Coal

By T. E. WARREN.*

INTRODUCTORY.

The purpose of this paper is to describe the chief processes for the hydrogenation of coal, coal tars, bitumen and petroleum, and to draw some conclusions concerning their applicability to Canadian fuels.

Information for this paper has been obtained from a complete review of technical periodicals, text books and abstracts published since 1914; from the results of experimental work by the writer on the hydrogenation of Alberta bitumen, low temperature coal tar, and peat; and incomplete review of patents; and from communications from members of organisations engaged in hydrogenation. The subject is not one which lends itself readily to theoretical analysis; and for this reason the large numbers of investigators have been compelled to obtain their data empirically. Most of this data has resulted from brief programmes of experiments, the conditions of which differ fundamentally from those of the large scale developments. Successful processes have been developed by the I.G. Farbenindustrie in Germany, and the Standard Oil Company in the United States. During the past year the Imperial Chemical Industries, Ltd., has been operating a 10 ton-per-day plant at Billingham, England. These companies, however, have disclosed only part of their operating methods, and have kept secret such essential details as the composition of the catalysts, their methods of preparation, and manner of use. In addition, their patents are difficult to interpret. Therefore, in preparing the following report, it has been necessary to select critically from different sources of information.

In its broadest sense, the term "hydrogenation" includes any treatment with hydrogen. The hydrogen may react with the predominating constituent of the material treated, with a constituent present in comparatively small amount, or may not react at all, but by its presence may influence other reactions. As generally applied to fuels, the term includes any combination of these influences. Chemical reactions involved in hydrogenation is illustrated by the following description of the effect of temperature and of hydrogen on high-boiling paraffin hydrocarbons.[1] The large molecules of which these are composed, under the influence of high temperature,

* Research Engineer, Fuel Research Laboratories, Division of Fuels and Fuel Testing, Mines Branch, Department of Mines, Ottawa, Canada.

break into two or more smaller molecules, of which at least one is unsaturated. The unsaturated molecules have a tendency to unite to form large aggregates which split and reunite still further until a solid coke-like material is formed. However, if sufficient hydrogen can be added to the unsaturated primary products, they lose the tendency to unite, and remain as light oils and gas instead of forming coke. As an illustration, the cracking processes, in which petroleum oils are heated without the addition of hydrogen, usually produce a considerable yield of coke, but the new commercial process of oil hydrogenation does not. The hydrogen reacts more completely and quickly if it is at a high pressure, and if hydrogenating catalysts are present.

Although the hydrogenation of coal and coal tars is similar, it is complicated by the presence of impurities and the complexity of the hydrocarbon structure. By the new catalytic processes, however, oxygen, nitrogen, and sulphur are removed as water, ammonia and hydrogen sulphide respectively.

HYDROGENATION PROCESSES.

Of the several suggested processes for hydrogenation the Bergius process was the first to demonstrate the possibility of hydrogenating coals and oils commercially. Later, the I. G. Farbenindustrie and the Standard Oil Company brought out a new process which has many advantages over the earlier Bergius process. Although all these processes are essentially the same they differ in some details, and for this reason a brief description of each is given.

The Bergius Process: In 1913 Bergius was granted a patent, according to which petroleum spirit could be made from heavy heavy hydrocarbon oils[2] at a temperature of 450° C., and under hydrogen pressure of more than 20 atmospheres. In a later patent[3] an initial pressure of 100 atmospheres was specified. At about the same time, during experiments on the production of artificial coal from cellulose, Bergius found that coal could be, to a large extent, converted into liquid oils by hydrogenation. This process was the subject of British Patent No. 18232 of August 1st, 1914. After the war, Bergius' American patents for coal and oil hydrogenation were assigned to the Chemical Foundation, Inc., ad were offered for sale in October, 1930.[4]

In 1912, after his first laboratory experiments, Bergius received the support of the A.G. fur Petroleumindustrie, and in 1916, a group of German financiers and technologists formed the Konsortium fur Kohlenchemie which later began operations under the name of the Erdol and Kohlenverwertung A.G. In 1922, the Erdol and Kohlenverwertung entered into negotiations with the Royal Dutch Shell Company, which resulted in an agreement in connection with the international rights of the Bergius process.[5] Bergius' plant at Rheinau was developed to a large scale through its use, up to 1922, for the hydrogenation of oils[6] After 1922, it was used in part for experiments on coal hydrogenation and by 1926 a unit had been constructed which was capable of treating 100 tons of coal per day.[7] Subsequently the I.G. Farbenindustrie obtained the hydrogenation rights in Germany, and Bergius discontinued work on the subject.

The process finally developed at Rheinau by Bergius was as follows :[8] Coal was powdered to less than 0.1 inch size and mixed with about 40 per cent. of its weight of oil from a previous cycle and 5 per cent. of ferric oxide. The mixture was pumped through a heat exchanger into a horizontal reaction chamber. The temperature of the reaction chamber varied with the material charged, and was usually 450 to 490° C. for coal. Hydrogen at about 200 atmospheres pressure was admitted through a heat exchanger at the inlet end of the reaction chamber. Both liquid and vapour passed to the exit end of the reaction chamber where the gas (hydrogen and other gases) was removed and recycled after the light oils had been condensed from it. The liquid was passed to a second and third reaction chamber of similar construction, but operating at different temperatures[9]. The liquid product from the third stage was fractionated. Sulphur was removed from the coal as iron sulphide by the iron oxide added in the charge. The time of contact of the charge in the various stages is uncertain. It was probably about one hour in each stage. Longer times of contact were used in the earlier small scale experiments.

The yields obtained from a typical coal by the Bergius process, including carbonisation of the residue from hydrogenation, are as follows :—[8]

Product	Yield as weight % of coal charged
Neutral refined motor spirit (boiling range, 86-446°F)	15.0
Diesel oil and creosote oil ...	20.0
Lubricating oil	6.0
Fuel oil	8.0
Gas	23.5
Coke	24.0
Water	7.5
Ammonia	0.5
Loss	5.5
	110.0

The total is greater than 100 per cent. by the amount of hydrogen (5 per cent.) and of iron oxide (5 per cent.) added to the original charge.

Although the plant at Rheinau operated commercially on oil during the war, the process of coal hydrogenation described above never passed the experimental stages. It had the fundamental faults; (*a*) that the rate of addition of hydrogen was not great enough, (*b*) that sulphur was removed as solid iron sulphide, the accumulation of which interfered with recycling, and (*c*) that oxygen-containing compounds such as cresols were not changed which resulted in a large refining loss.

The Process of the I. G. Farbenindustrie : The development of the Bergius process was to some extent paralleled up to 1926 by that of the I. G. Farbenindustrie. Later this company obtained the hydrogenation rights in Germany and continued the experiments on a large scale. At present, a plant is being operated commercially at the Leunawerke of the I. G. near Merseburg in the brown coal district. It has a capacity of about 10,000 barrels per day and uses as a raw material brown coal tar and petroleum oils.[10]

Although the present process of the I. G. has been developed from that of Bergius, it differs in that special catalysts are used. These increase the velocity of the hydrogenation reaction so that the throughput is increased and coke formation eliminated, and bring about the conversion of oxygen-containing compounds to hydrocarbons, and the elimination of organic sulphur as hydrogen sulphide. The catalysts are not removed after one passage through the apparatus, as was the iron oxide in the older process, but are continually recycled.[11]

Since conflicting statements have been made concerning the operating details of the I.G. process, it is not possible to describe them with certainty. They are thought by the writer to be as follows :—

The untreated tar is mixed with the catalyst and passed through coils 4 inches in diameter and 1,000 feet long. Hydrogen is introduced at the inlet to the coils at a pressure of about 3,000 pounds per square inch. The final temperature attained in the preheater is about 425°C. when coal tar is being treated. The solid-liquid-gas mixture passes to the reaction chamber, a cylinder 58 feet high and 2½ feet in internal diameter.[10] In the reaction chamber, the pressure is about 3,000 pounds per square inch and the temperature, which varies with the different materials, is about 455° C. for coal tar. The gas is removed from the top of the reaction chamber and the light oil which it contains is condensed or absorbed under pressure. The uncombined hydrogen is passed through a purifying train, its pressure increased to 3,000 pounds per square inch, and it is returned to the inlet end of the preheating coil. The liquid containing the catalyst is continuously pumped from the bottom of the reaction chamber, mixed with fresh charging stock and passed to the inlet of the preheater. A second stage of hydrogenation may be used for further treatment of the light oil product.[11]

The Standard oil hydrogenation process of the Standard Oil Company, which is probably identical in principle, is stated to be so flexible that by changing conditions of temperature, pressure, duration, and catalysts, products ranging from lubricating oils to anti-knock gasoline can be produced in the same equipment.[12] When operating on coal tars or petroleum oils there is no solid product. All of the charge leaves the apparatus as liquid or gas. It is possible to produce more than 75 per cent. by weight (approximately 100 per cent. by volume) of gasoline from coal tar or low-grade petroleum residues by repeated recycling. The process is on a commercial basis in the United States where the Standard I.G. Company has erected a 5,000-barrel-per-day plant for the hydrogenation of petroleum. The first plant at Bayway, N.J., has been duplicated at Baton Rouge, La., where commercial operation began early in 1931 so that the process as applied to petroleum has apparently gone beyond the large scale experimental stage.[11]

From the description of the process, it has been seen that continuous operation is possible only if all of the charging stock can ultimately be removed as vapour from the reaction chamber, unless fresh quantities of catalyst are continuously supplied. Accordingly, coal or other materials containing matter which cannot be volatilised do not readily lend themselves to the process. Pastes of powdered coal and oil are said to have been hydrogenated by the I.G. by a procedure similar to the one described,[11] but it is not probable that any appreciable part of their gasoline production comes from this source.

Combined Processes : Many combinations of hydrogenation with other operations are possible. One of these, suggested by Bergius, and used to some extent by the I. G. Farbenindustrie, is the combination of a coke oven and hydrogenation plant.[14] Hydrogen formed at the end of the coking run is used to hydrogenate coal tar so that the unit is self-contained.

The Standard-I.G. Company uses the hydrogenation plant as auxiliary equipment in oil refineries. Natural gas or gas from a cracking process is combined with steam to produce hydrogen. The residue from cracking is hydrogenated.[12] Asphalts and asphalt-base residues may in some cases be economically hydrogenated to such an extent that they may be distilled without coke formation and later be converted to gasoline by one of the cracking processes.[11]

The Work of the British Fuel Research Board.

The only organisation operating a semi-commercial scale unit which publishes its results is the British Fuel Research Board. In 1924 the Board made plans to study hydrogenation, especially as applied to British coals, and in 1925 work with small bombs was begun at the Fuel Research Station. An agreement was also made with the International Bergius Company by which experiments were carried out at Rheinau to test the suitability of British bituminous coals for hydrogenation.

In February, 1927, a continuous plant capable of treating one ton of coal per day was put into operation at the Fuel Research Station. It was very similar in construction to that of Bergius at Rheinau. In operating, powdered coal was mixed with oil or tar and iron oxide to make a stiff paste which was forced by a hydraulic press into the first of three reaction chambers to which hydrogen under pressure was also supplied. The mixture was passed through the three reaction chambers in series to a separator and condenser from which the gas was passed through a second condenser and scrubber to the gas holder. The bombs were heated in lead baths to ensure close temperature control. Since 1927, work has been continued using both the plant and the laboratory-scale bombs, on a variety of investigations. Until recently, the plant has been run under the conditions of the Bergius plant in 1927. Various amounts of iron oxide and varying temperatures as well as different coals were tried. Coal has also been distilled at 430° C. in a current of hydrogen at high pressure using iron oxide as a catalyst. The yield and quality of the oil produced in this was better than that obtained by passing hydrogen and charge together through the bomb. The new method has not been carried out continuously.

Other experiments have concerned the hydrogenation of tar and oils, the partial hydrogenation of non-coking coals to produce coking coals, and the production of hydrogen.

The reports of the Fuel Research Board are received about a year after the work has been completed and no detailed description has been compiled. However, the conclusions are free from commercial interest and are based on a large fund of information. In the report covering the work to March 31st, 1928, the following statements are made : " . . . with our present knowledge it is safe to assume that the cost (of producing oil directly from coal) would be considerably greater than the price at present ruling for imported oils although it should be less than the price of imported oils which ruled in 1917-18 "; " . . . improvements to reduce the cost of working may be expected, notably in the cost of hydrogen production or in the recovery and re-use of the hydrogen in the gaseous products of the process."

Cost Calculations.

In 1927, H. Bruckmann, who was president of the Erdöl und Kohlenverwertung A.G.—the organisation controlling the Bergius interests—stated that the cost of treating one metric ton of coal by the Bergius

process was 71 marks.[5] The valuable product obtained from the treatment was 65 per cent. by weight of crude oil which contained 25 per cent. of gasoline, 30 per cent. of Diesel oil, and 10 per cent. of lubricating oil based on the original coal. These figures were used by A. C. Fieldner[15] to show that the cost of gasoline produced directly from coal would be about 26 cents per gallon† in the refinery in Germany, and about 40 to 50 cents at the refinery in America. Fieldner's calculations were based on the assumption that the crude oil produced from coal hydrogenation would be cracked to yield 50 per cent. of gasoline.

Under normal conditions gasoline is worth 7 to 9 cents per gallon at the refinery in the United States.[15] The Standard-I.G. process for oil hydrogenation, as has been previously noted, is expanding. It is apparent, therefore, that even if the raw material has no value the cost of processing cannot be greater than 9 cents per gallon, U.S.

This apparent contradiction in the estimation of costs, is, in part, explained by the fact that the processes of coal and oil hydrogenation yield different products. In the hydrogenation of oil a charging stock of low value is converted to 75 per cent. by weight of gasoline. In the case of coal the yield is only 25 per cent. by weight of gasoline unless further steps are taken. For instance, if Bruckmann's estimate for processing a metric ton of coal (2,205 pounds) be assumed to apply to the processing of a metric ton of oil, the cost per Imperial gallon of gasoline produced is 8.05 cents.

It is possible to make an approximate calculation of two of the most important items of expense in the I. G. Standard-I. G. processes, namely, equipment charges and hydrogen cost.

The cost of large hydrogenation plants, calculated from the data of different writers, varies between $700 and $2,500 per barrel of 35 Imperial gallons daily capacity (16, 10, 17, 5). If the cost assumed to be $2,000 per barrel per day and the depreciation and maintenance charges to be 15 per cent., the charge per Imperial gallon for this item is 2.45 cents.

† In quoting the paper by A. C. Fieldner, the writer has assumed that the figures relating to costs are obtained on U.S. gallons. The cost per Imperial gallon may be obtained by multiplying by 1.2.

A recent review of methods of hydrogen production gives the cost of hydrogen by the reaction of steam with natural gas as 11.0, 14.1, and 17.2 cents per thousand cubic feet, when the cost of natural gas was 5, 15, and 25 cents per thousands cubic feet respectively.[18] Natural gas can be transported in pipe lines for 2.5 cents per thousand cubic feet per 100 miles so that the three costs represent the value of waste natural gas at 200, 600, and 1,000 miles respectively[19]. Where the cost of electric power is 15 dollars per horse-power year, and the overall efficiency of motor and compressor is 50 per cent., the cost of compressing 1,000 cubic feet of hydrogen from one atmosphere to 200 atmospheres is 1.94 cents for power. Assuming other charges, *i.e.*, labour, fixed charges, etc., on the compressor to be 4.0 cents per thousand, the total cost for hydrogen compressed to 3,000 pounds per square inch is about 21 cents per thousand. In the production of gasoline from coal tar, about 4 per cent. of hydrogen is combined.[20] Assuming an equal amount to be lost in compression, scrubbing, etc., the cost of hydrogen per Imperial gallon of gasoline is 3.02 cents.

The combined cost of the two items is, therefore, 5.47 cents per Imperial gallon. While it is obvious that much of the calculation was based on uncertain data, and that there are additional items of expense, the figure shows that it is reasonable to expect that the production of gasoline from petroleum residues and coal tars can compete under some conditions with the distillation and cracking methods used at present.

Officials of the Imperial Chemicals Industries have stated that gasoline could be produced by their process in England for 14 or 15 cents. per Imperial gallon, of which 4 cents is the cost of the coal.[21] Imported gasoline is taxed 16 cents per gallon so that the process could be operated commercially at a profit if manufactured gasoline were exempt from taxation. Since it would benefit the coal-mining industry and help to relieve unemployment in England the process is the centre of much interest. By comparison with the calculations of Bruckmann[5] and Fieldner[15] it is seen that the estimated cost of the direct production of gasoline from coal has fallen from 31 cents per Imperial gallon in 1927 to 14 cents in 1931.

The Application of Hydrogenation to Canadian Fuels : In central Canada it is

probable that the process will first be used as an adjunct to the plants refining imported petroleum oils. Since this phase is already developed and in use commercially in the United States, it may be adopted very soon. The use of lignite and peat as raw materials presents interesting possibilities but depends on further development of an adaption of hydrogenation to these materials.

In Alberta, bituminous coal and bitumen are possible raw materials.[22 23 24] A recent estimate, made by the Alberta Research Council[25] of the cost of separating one ton of bitumen from bituminous sand is \$4.20. Assuming \$1.80 as the cost of mining and transporting to the separation plant a sufficient quantity of bituminous sand to produce one ton of bitumen, the value of one ton of bitumen becomes \$6.00—which is greatly in excess of the cost of a ton of coal. Therefore, although there is every indication that the cost of hydrogenation will be much lower for bitumen than for coal, it is difficult to predict to what extent (if any) motor fuel may be produced cheaper from bitumen than from coal. Further laboratory and large-scale work will be necessary before data concerning the comparative costs can be obtained.

Hydrogenation is economically possible only on a large scale. Therefore in the case of small-scale developments for obtaining gasoline from bitumen some combination of topping and cracking processes, using the residue as paving material, would be preferable to a small hydrogenation unit.

In the Maritime Provinces, imported petroleum and native bituminous coal are the principal materials for consideration. The coal might be directly hydrogenated or, more probably, carbonised to coke or semi-coke and tar. The tar could then be hydrogenated to produce motor fuel. Shale oil, due to its comparatively high cost of production, is only remotely to be considered as a source of material for hydrogenation.

The hydrogenation processes will probably attain full development only after the supply of natural petroleum has become appreciably depleted. However, it is impossible to predict when commercial operation on any given material will begin as estimates of the reserve of petroleum cannot be made with certainty, and improvements in hydrogenation are to be expected. The expansion of the industry to coal and other raw materials will probably be a gradual one following the development of oil hydrogenation which, in the United States and Germany, has already begun.

LITERATURE CITED.

1 S. A. Kiss, *Jour. Ind. Eng. Chem.*, Vol. 23, p. 315 (1931).

2 German Patent No. 304,348 (1913). U.S. Patent No. 1,344,671, June 29 (1920).

3 British Patent No. 4574 (1914).

4 *Jour. Ind. Eng. Chem.*, Vol. 22, p. 9, October, 1930.

5 H. Bruckmann, *Min. Jour.*, Vol. 160, 69-70, 94, 116 (1928).

6 J. I. Graham, *Iron and Coal Trades Rev.*, Diamond Jubilee Issue, 87-90, December, 1927.

7 A. E. Miller, *Amer. Pet. Inst.*, Vol. 8, 152-9, Jan. 31, 1927.

8 F. Bergius, First International Conference on Bituminous Coal, Carnegie Institute of Technology, Pittsburgh, Pa., p. 102, November, 1926. See also :— *Nat. Pet. News*, Vol. 18, 47-53, 1926; *Ind. Eng. Chem.*, News Edition 4, No. 23, 9-10, 1926; *Can. Chem. Met.*, Vol. 10, 275-9, 1926.

9 Bergius, *Sci. Amer.*, Vol. 140, 322-24 (1929).

10 A. L. Foster, *Nat. Pet. News*, August 13, 1930.

11 Lecture to Montreal Section of Soc. Chem. Ind., March 18, 1931, by R. P. Russell. (See *Can. Chem. Met.*, Vol. 15, 95-97, 1931.)

12 Haslam and Russell, *Jour. Ind. Eng. Chem.*, Vol. 22, 1030 (1930).

13 Annual reports of the (British) Department of Scientific & Industrial Research, H.M. Stationery Office, London.

14 Bergius, U.S. Patent No. 1,669,439, May 15, 1928.

15 A. C. Fieldner, *Fuel*, Vol. 7, 492-501, 1928.

16 Truesdell, *Nat. Pet. News*, 21, No. 28, 1929.

17 A. W. Nash, *Jour. Inst. Pet. Tech.*, Vol. 10, 329-34, 1924.

18 *Chem. and Met.*, Vol. 38, 40, 1931.

19 *Chem. and Met.*, Vol. 38, 213, 1931.

20 *Iron and Coal Trades Review*, 107, 735, 1923.

21 *Jour. Soc. Chem. Ind.*, Vol. 50, p. 669, 1931.

22 Research Council of Alberta, *Report* No. 26, p. 26, 1930.

[23] Boomer and Saddington, *Can. Jour. of Research*, National Research Council, Ottawa, Vol. 2, p. 376, 1930.
[24] Boomer and Saddington, *Can. Jour. of Research*, National Research Council, Ottawa, Vol. 4, 517, 1931.
[25] Research Council of Alberta, *Report* No. 26, p. 56, 1930.

Received 8th March, 1932.]

DEMONSTRATION OF THE COOLING EFFECT PRODUCED BY THE RAPID EXPANSION OF AIR.

In the course of some experiments on the viscosity of enzyme-starch digests, in which an ordinary slow-delivery 10 c.c. pipette was used as a viscosimeter, it was found convenient to clean the pipette between the determinations by drawing distilled water in through the jet by suction from a filter-pump atached to the wider end. On one occasion the beaker containing the distilled water used for this purpose became empty while the pipette was only half-full, with the result that the air drawn rapidly through the narrow jet of the burette bubbled rapidly upwards through the water in the lower half of the pipette. After about 10 seconds it was noticed that a cylinder of ice, with a narrow central channel through which the air continued to pass, had formed inside the jet. In the course of a few minutes, this grew progressively upwards, until it reached the wide middle bulb of the pipette, which eventually was half-filled with ice. After this stage continuation of the experiment produced no further increase in the amount of ice produced.

Apparently the air passing through the fine jet had been sufficiently cooled by expansion to freeze the thin film of water on the walls of the tube. The progressive increase in rate of growth of the column was doubtless due to the pre-cooling of the incoming air by the surrounding ice as it passed up the central capillary channel. About 5 c.c. of ice were formed in a few minutes and the central channel, whose diameter appeared to be approximately that of the jet of the pipette, extended from the bottom to the top of the column.

The temperature of the room (and the water) was about 20°C., and the diameter of the pipette was such as to allow the delivery of 10 c.c. of water about 6 minutes. The pipette was not lagged in any way, and under more efficient experimental conditions it should be possible to make fairly large amounts of ice in a comparatively short time.

L. W. JONES.
JULIUS GRANT.

Hackney Technical Institute, London.

THE DEHYDRATION OF SALTS WITH ORGANIC LIQUIDS.

By J. G. F. DRUCE, M.Sc.(Lond.), R.Nat.Dr.(Prague), F.I.C., F.C.S.

Several investigators have recently made use of organic liquids in the drying and dehydration of salts. Thus, M. Copisarow (*Nature*, 1931, *128*, 838) states that when toluene is distilled over crystalline copper sulphate, water vapour accompanies the toluene and anhydrous copper sulphate remains. He also mentions that the salts of other metals can be similarly dehydrated and that the process is of general application.

Crystalline stannous chloride ($SnCl_2$ $2H_2O$) had previously been dehydrated by H. Stephen (*J. Chem. Soc.*, 1930, p. 2786) by heating with acetic anhydride. The anhydrous salt was filtered off, having resulted from a definite chemical action.

The present writer has recently distilled toluene (b.p. 110) over crystalline manganese sulphate, $MnSO_4$ $4H_2O$, until the distillate came over free from water. An amorphous solid remained, which was pressed between bibulous paper and then left in an exsiccator over solid potassium hydroxide for several days. The amorphous residue so obtained was not, however, the anhydrous salt, since on heating it evolved water, which on coming in contact with anhydrous copper sulphate turned it blue.

On analysis this salt was found to be manganese sulphate monohydrate.

0.5525 gr. substance gave 0.7617 gr. $BaSO_4$; per cent. SO_4, 56.44;
1.2430 gr. substance on heating lost 0.1318 gr. per cent. water, 10.61;
$MnSO_4H_2O$ requires SO_4, 56.8 and H_2O, 10.65 per cent.

The distillation of xylene (b.p 139-41°C.) over either the mono- or the tetra-hydrated

manganese sulphate also did not produce the anhydrous salt even after prolonged distillation. On the other hand with nitrobenzene (b.p. 207°C.) and a saturated hydrocarbon oil of high boiling point (190-195°C.) the hydrated salts were completely dehyrated, the crystals yielding somewhat discoloured, anhydrous manganous sulphate. Recently H. Krepelka and B. Rejha (*Collection of Czechoslovak Chemical Communications*, 1931, *3*, 517-35), after an exhaustive investigation, have shown that manganous sulphate is obtained anhydrous at 450°C. and that the monohydrate is stable up to nearly 200°C., above which it begins to lose water. From the results of the Czechoslovak investigators it is easy to understand that complete dehydration of hydrated (4- or 7-) manganous sulphate by the method of distilling toluene over these salts is improbable. With copper sulphate crystals the same results were obtained with toluene. Complete dehydration was obtained with nitrobenzene and the high-boiling hydrocarbon.

Using Stephen's method, it was also found that both crystalline copper sulphate and hydrated (4) manganese sulphate could be readily dehydrated by warming with excess of acetic anhydride without having recourse to distillation. When the solid residue was filtered off, drained and dried, it was found to be perfectly anhydrous. The action of acetic anhydride is, however, not the same as in the case of those liquids which remove the water as vapour, since the acetic anhydride must react with the water of crystallisation of the salt with the formation of acetic acid.

CANADIAN SANDS PROVE SATISFACTORY FOR SAND BLASTING

Highly encouraging results have been obtained by the Department of Mines, Ottawa, on a series of tests conducted on Canadian sands to determine their suitability for sand blasting purposes. According to Mr. L. H. Cole who conducted the tests jointly with Mr. R. K. Carnochan and with the close co-opertion of Mr. W. E. Brissenden, of the Department of Development, Canadian Pacific Railway, there occur in Canada a number of sands that are well suited for the purpose and that are the equal, and in many cases superior to imported material now being used so extensively.

REVIEWS OF MODERN PHYSICS.

The current issue of the above journal (January) contains four articles as follows: Interpretation of Band Spectra (Part III) by R. S. Mullikan; Quantum Theory of Radiation, by E. Firmi; Electric and Magnetic Double Refraction, by J. W. Beams; General Relativity, by B. Hoffman. These in all cover pages 1 to 173.

Mulliken's article on band spectra is very complete. It is " largely a review of theoretical relations with a critical interpretation of experimental material, and is based on papers of Hund, Weizel, Herzberg, Wigner, Witmer," the author and others. Some new interpretations are given. The treatment of molecules is not yet in terms of wave mechanics, but this advance may appear later in book form when the whole subject will be more completely dealt with. At the same time there is so much in this article one marvels at the enormous amount of work being put into such recondite matters.

The quantum theory of radiation is now a very big subject and Fermi has presented a large amount of valuable matter. A theory of radiation that satisfactorily dealt with the conflicting features of interference phenomena and that of emission and absorption is of comparatively recent date involving Dirac's theory. This is treated at length and in further development the introduction of the relativistic wave equation of Dirac as applied to the electron is discussed in connection with the theory of radiation. Quantum electrodynamics also comes into the picture which is largely mathematical. It appears that Dirac has proposed a very simple idea to elucidate radiation. The atom and the interacting radiation field are treated as a single system, the energy of which is the sum of three terms: (1) atom energy, (2) electromagnetic energy of the radiation field and, (3) " a small term representing the coupling energy of the atom and the radiation field." This Fermi explains by means of an analogy when neglecting the small term.

The article by Beams deals largely with the Kerr effect and the Cotton-Moulton effect. These two effects fall respectively under the headings electric and magnetic double refraction. A great deal of material is brought under review and the theories respecting these effects are discussed fully. Like most of the articles in this journal,

references are very profuse and in this case there are 196.

Coming now to our old friend Relativity, which like the poor is always with us, in Hoffman's exposition of this subject new observational ground appears to be broken. On page 173-174 the following is of interest: "The omission of any consideration of quantum phenomena is more serious; it is not that we merely refrain from discussing the equations of the quantum theory—siuce we shall anyway not discuss field equations —but that, in all that follows, we must definitely ignore the implications of the uncertainty principle. The general relativity theory is based upon the assumption that measurements can be refined to any desired degree of accuracy, the effect of the operation of measurement upon the system under observation being ignored. General relativity is in this sense classical and the appropriate extension to embrace the ideas of the quantum theory is not yet known. It remains nevertheless the best theory of gravitational phenomena and avoids many of the difficulties of the Newtonian theory." It is certainly confusing to have to think of the uncertainty principle as due to the disturbance of measurement and at the same time associate it with an inherent property of the atom (see Sir Arthur Eddington's article in *Nature*, 1932, *129*, 233)—to insert a comment here. Hoffman further says:— "In the relativity theory we start out with the assumption that every physical observation consists essentially of a succession of sets of four measurements; that is we assume that the world can be thought of as four-dimensional. So far we have said nothing startling; precisely this assumption lay at the bottom of the whole of classical field physics; it was pointed out by Laplace, for example, that particle dynamics is geometry of four dimensions in which time is the fourth dimension." The author might have mentioned, incidentally, Wells' TIME MACHINE in this connection as it was published before Einstein's theory came out, but the subject is mathematical, and of course we know that the theory of relativity involves more than this; for example, the velocity of light as a sort of standard which is taken as a universal basis. One has to be pretty well steeped in these subjects to follow the arguments, but for those delving deeply in them, this journal should be of great use.

F. H. LORING.

INSTITUTE OF CHEMISTRY.

At the fifty-fourth Annual General Meeting of the Institute of Chemistry held in the Hall of the Institute, Russell Square, on Tuesday, 1st March, the President (Dr. G. C. Clayton, C.B.E., M.P.), presented the Meldola Medal, the gift of the Society of Maccabaeans, to Dr. Guy Frederic Marrian, of University College, London, in recognition of his researches on vitamins and hormones.

The Annual Accounts were received and adopted on the motion of the Hon. Treasurer, Mr. Patrick H. Kirkaldy, who made a special appeal for the Benevolent Fund.

In moving the adoption of the Report of Council, the President said that the roll of Fellows and Associates of the Institute exceeded 6,000. The proposal to petition for a Supplemental Royal Charter, with a view to securing for the members the use of the title "Chartered Chemist," had been postponed, because the Pharmacy and Poisons Bill, which contained a clause dealing with the use of the word "chemist" and was before the last Parliament, had not been re-introduced. In any event, amendments would be made in the Petition and Supplemental Charter in order to remove certain misunderstandings which had arisen with other organisations.

The Institute had been represented on the Joint Chemical Committee on Patent Law Reform, members of which had given evidence before the Board of Trade Committee, and a form of contract of service for chemists in industry had been prepared by a Joint Committee of the Institute and the Association of British Chemical Manufacturers. The Public Appointments Commttee had prepared a memorandum on the administration of the Food and Drugs (Adulteration) Act for the Departmental Committee on Food, which would, no doubt, be considered when the proceedings of the latter Committee were resumed. The Report showed that many important and interesting papers had been read before the Local Sections, of which there are fourteen in Great Britain and Ireland, and in Malaya, New Zealand, and South Africa.

The professional examinations of the Institute were maintained at a high standard, and the examinations, arranged by the Board of Education and the Institute

jointly, for National Certificates in Chemistry were proving of real value in co-ordinating and raising the standard of chemical training in technical colleges.

Having referred to the separate publication of Dr. Tocher's lecture on "What is Probable Error?" Dr. Vargas Eyre's Streatfeild Memorial Lecture on "Fermentation," and Sir Frank Smith's Gluckstein Memorial Lecture on "Chemistry and the Community," the President emphasised Sir Frank Smith's view that, even in these difficult times, chemical research must be continued. New problems were awaiting solution, and many which had been solved had yet to be developed on the large scale. The times had not been favourable for making radical changes or for launching out in new directions, but the chemical industry was an excellent barometer for indicating the outlook in industry generally, because it supplied some of the materials required for so many industries, and he thought that signs of a change for the better were not lacking.

The Appointments Register Committee reported that about 190 (or rather more than 3 per cent.) of the members were without appointments, and asked that suitable vacancies should be brought to the notice of the Institute. Incidentally, the President mentioned that the number of unemployed qualified professional chemists in Germany was 1,500 out of about 10,000—15 per cent.

Remarking that the duties of the Censors of the Institute had been light, the President deplored the practice of certain institutions, which disregarded professional tenets by soliciting practice and giving certificates for the purposes of advertisement.

The Officers and Council for the ensuing year were elected.

AN INDEX TO ACTS OF PARLIAMENT, ETC., AFFECTING THE CHEMICAL INDUSTRY.

We have received from the Association of British Chemical Manufacturers an index to Acts of Parliament, Statutory Rules and orders affecting the Chemical Industry in Great Britain. The whole field of legislation affecting this branch of industry has been covered and the index should prove valuable to those operating in the industry or to those about to commence the manufacture, shipping or trading in chemicals.

Proceedings and Notices of Societies

THE PHYSICAL SOCIETY.

Award of the Duddell Medal to Professor C. T. R. Wilson, M.A., D.Sc., LL.D., F.R.S.

The contributions of Professor C. T. R. Wilson to Physical Science fall mainly into two groups; those associated with the investigation of the tracks of ionising particles on the one hand and the investigation of atmospheric electricity on the other. The word "cloud" is the appropriate symbol of both groups.

The study of the condensation of drops of water round ionic and other nuclei led him to the invention and perfection of the expansion apparatus, one of the most potent instruments of physical investigation ever devised. In his Nobel lecture delivered at Stockholm on the 12 December, 1927, Professor Wilson has related how his attention and interest were directed to cloud phenomena. During a short visit in September, 1894, to the Observatory which then existed on the summit of Ben Nevis his interest was excited by the optical phenomena (coronas and glorris) which the sun and the clouds collaborated in producing. On setting to work (1895) to attempt the reproduction of the phenomena in the laboratory ,the optical features soon fell into the background, by reason of the discovery that clouds could be produced in a super-saturated atmosphere which had been freed from the dust particles which the earlier experiments of Aitken indicated as an indispensable condition for initiating condensation. A definite critical expansion ratio ($V2/V1=1.25$), corresponding to a 4-fold super-saturation was found. No drops were formed in moist air free from Aitken's nuclei unless the expansion exceeded this limit; but a shower of drops was seen to fall when it was exceeded. These early experiments were communciated to the Cambridge Phil. Society in May, 1895. The use of a more elaborate apparatus led to the discovery of a second critical expansion, corresponding to 8-fold super-saturation. When this expansion was exceeded, dense clouds, consisting of very fine drops and associated with beautiful colour phenomena, were formed. Experiments with various pure gases led to results not differing essentially from these. The dense clouds formed

when the higher critical expansion was exceeded were, naturally, explained by supposing that the gas molecules themselves played the rôle of Aitken's nuclei and the interest of the experiments now centred mainly in the condensation which occurred between the two critical expansions. This was suspected to be due to the presence of charged atoms.

Roentgen's discovery became known in Autumn, 1895, and very soon afterwards J. J. Thomson was investigating the conductivity of air exposed to X-radiation. In consequence, Professor Wilson was able to make use of an X-ray tube which had been made by Mr. Everett in the Cavendish Laboratory. He observed again no formation of drops or clouds in dust-free aid when the expansion was less than the critical value 1.25; but when the expansion was between the rain-like and cloud-like limits a fog was produced which fell very slowly. Further experiments revealed that purely ionising agents all produced nuclei on which water condensed when, and only when, the super-saturation exceeded the lower critical limit. The condensation nuclei were shown to be ions by their behaviour in an electric field. Then followed the separate study of condensation on negative and positive ions which brought out that a critical expansion corresponding to 6-fold super-saturation was necessary for condensation on positive ions.

Mention should be made here of the application of these investigations to the measurement of the ionic charge by J. J. Thomson, H. A. Wilson and R. A. Millikan, and also of the fact that the degree of super-saturation required to cause negative ions to grow into visible drops leads to the value 4.9×10^{-10} e.s.u. for the elementary charge.

The earlier experiments of C. T. R. Wilson which indicated, as has been said already, that the rainlike drops formed between the two critical expansion limits might be charged atoms, suggested that there might be a measurable conduction of electricity in a closed vessel containing dust free air. This Professor Wilson was able to demonstrate by a method which is now familiar to all physicists and has since found a wide application.

As long ago as 1911 Professor Wilson had spent much time in devising a suitable form of expansion apparatus and an efficient means of instantaneous illumination of the cloud particles for the purpose of photographing them and he relates that it occurred to him, at a time when these tests were still incomplete ,that it might be worth while to take a photograph with the rough apparatus already constructed, in the hope of observing the tracks of ionising particles. In his Nobel lecture he says: "The first test was made with X-rays, and with little expectation of success, and in making an expansion of the proper magnitude for condensation on the ions while the air was exposed to the rays I was delighted to see the cloud chamber filled with little wisps and threads of clouds—the tracks of the electrons ejected by the action of the rays. The radium-tipped tongue of a spintharoscope was then placed inside the cloud-chamber and the very beautiful sight of the clouds condensed along the tracks of the x particles was seen for the first time."

Long ago Professor Wilson observed on the path of a primary X-ray beam a large number of little patches of cloud representing the paths of very short cathode rays, the interpretation of which he considered required further investigation. These are now known to be the tracks of the recoiling electrons in the Compton effect.

The final improvement of the expansion method consisted in taking stereoscopic pictures of clouds. During the past decade the method has been used bw Professor Wilson, his pupils and others with refinements which have made it possible to attain much greater accuracy than that associated with earlier experiments. The work of Blackett in particular on collisions of particles with atomic nuclei, and on the atomic disintegration thereby produced, may be instanced.

The work of Professor Wilson in atmospheric electricity has opened up new and profitable fields of inquiry. His method of studying rapid changes of the earth's electric field, which is characterised by the experimental elegance evident in all his work, has led, in his own hands and in the hands of those working under his guidance, to a great increase in our knowledge of the electric fields associated with thunderstorms. By studying the electric field changes at short distances from discharge channels Wilson made the first reliable determination of the magnitude of the electric charge dissipated in a lightning flash, while Appleton and Schonland, working at greater distances, have established the correctness of his view that thunder clouds are pre-

dominantly bi-polar, the positive charge being elevated above the negative charge. This work, together with Wormell's study of point discharges in thunderstorm fields, has led to overwhelming evidence in favour of Wilson's solution of what is probably the most important problem of all in atmospheric electricity, namely that of the maintenance of the earth's electric charge. The persistene of the earth's negative charge in fine weather regions, in spite of the dissipative action of the positive ion current constantly flowing from the air to the ground, can now be attributed to the action of thunder and showed clouds, the charges of which are so disposed as to send negative electricity into the ground in sufficient quantity to balance the dissipation.

SOCIETY OF GLASS TECHNOLOGY.

February 24.

The following papers were read :—

The Strength of Materials as Affected by Discontinuities and Surface Conditions. By PROFESSOR F. C. LEA, O.B.E., D.Sc., M.Inst.C.E., M.I.Mech.E. (Sheffield University).

In his introductory remarks, Professor Lea dealt with the different types of stress to which materials might be subjected, and the effects of repeated stresses as distinct from those of static stresses.

The effects of discontinuity of form such as a cut, or milled grove, and of discontinuity of internal structure, were described. The plasticity of materials played an important part and fortunately when the stress exceeded a certain amount, the materials used by the Engineer flowed, thus reducing the stresses at sharp curves to finite values. The range of stress during cycles, might, however, be such that ,although other parts of the element where the apparent calculated stress was the same as near to the discontinuity, and too low to cause fracture, yet failure might occur comparatively easily near to the discontinuity.

The effect of a discontinuity of known form had a less effect upon repeated stress conditions for a plastic than for a comparatively non-plastic body, and had much less effect under conditions of statical stress, as seen by comparing the behaviour of a glass rod and a copper wire. Many interesting examples of actual failures of machine parts due to discontinuities were cited.

Results of experiments carried out in the author's laboratories showed that under static stress, a groove or a thread did not of necessity weaken a specimen, some of which exhibited marked elongation. It was found, however, that the effect of a groove or a small hole or key-way was to reduce very materially the safe range of repetition stress. In mild steels the groove depth was important and further, the effect of nickel plating specimens were almost the same as the effect of sharp grooving.

Since glass was brittle, and not plastic, it might be expected that the full theoretical concentration of stress would occurr at the slightest discontinuity.

The type of apparatus used for testing spiral springs was described, and illustrated. Results of many tests had shown that the range of repetition stress to be expected from materials with a " Black surface," was only 30-70 per cent. of that expected from ground specimens of the same material. This could be explained by the oxidation of the surface, and an assumption that at the crystal boundaries charges were produced by the heat treatments and physical treatments, which caused concentrations of stress, and thus cracks to develop.

Cold working on steels produced surface conditions almost exactly similar to those produced by quenching and tempering. Wire ropes, therefore, like springs, although capable of taking high static stress, could only resist temparatively low repeated stresses.

Corrosion of steels seriously affected the safe range of repetition stresses and the stresses and the corrosive effect was influenced by the stress.

Specimens, were tested in a special repeated stress torsion machine, in baths of various solutions, in air and in baths through which electric currents were passed, the specimens acting as cathodes.

With a mild steel, tests in a caustic soda bath yielded a range of repetition stress a little higher than in air. In an acid bath the fatigue range was much less. In caustic soda the cathode was protected from corrosion. Hydrogen made the mild steel fail as though it were a hard, brittle steel, or as a mild steel in which a small hole was drilled.

A description was given of the standard-

ised type of specimens and apparatus used to determine the energy required to fracture a material in one blow, *i.e.*, its brittleness. The results showed the danger of grooves, in materials subjected to blows. For a carbon steel, corrosion, after a time, produced a lowering of the blow necessary to produce fracture.

Investigations on the Tensile Strength of Glass. By E. J. GOODING, B.Sc. (Rockware Glass Syndicate, Ltd., Greenford).

The author described a new method of determining the tensile strength of glass, in which the specimen took the form of rod, with a maximum diameter of 3 mm. The glass was all obtained from tanks of white flint, the composition being SiO_2, 73.80 : Al_2O_3, 0.75 :Fe_2O_3, 0.04 :CaO, 8.85 :Na_2O, 16.10 : MgO, 0.09, and all specimens were thoroughly annealed after the central restriction was made. Continuous and discontinuous loading were tried, the breaking load and diameter of the rod on breakage were measured and the fracture examined under high magnification. The effects of various factors were summarised as follows :

(1) *The Type of break obtained.*

Examination of a large number of specimens showed that the tensile strength of annealed glass specimens all made at the same time, and receiving similar treatment, varied considerably, one of the factors associated with the variation being the type of fracture. Generally speaking, a smooth fracture was associated with a lower value for the tensile strength than one which was largely rough. Some 60-70 per cent. of the specimens broke with one type of fracture, associated with some of the highest values.

(2) *The thickness of the specimen.*

The tensile strength of glass rods was found to decrease progressively with increased diameter of rod, this decrease being less rapid as the diameter increased, thus supporting the work of A. A. Griffith, which was compared and discussed at length. No effect of age was observed within a week after preparation of the samples.

(3) *The method of loading.*

Over the time periods employed, no essential difference was observed between results obtained for fracture of the rods under continuous and discontinuous loading.

Other factors tested were the effect of temperature at which the restrictions were made; state of annealing; annealing in sulphurous glass; etching and acid polishing.

The relationship between tensile strength and thermal endurance was also discussed.

Structure of Sillimanite and Related Materials. By W. H. TAYLOR, M.Sc. Ph.D. (Physical Laboratories, The University, Manchester).

Dr. Taylor gave an account of information gained by X-ray methods on the structures of sillimanite, cyanite and andalusite, the three naturally occurring forms of the compound Al_2SiO_5.

The difference between the triclinic form of cyanite, and the orthorhombic forms of sillimanite and andalusite was due to the fact that in the first mentioned form the oxygen atoms were close-packed, while in the other two cases they were not. Andalusite differs from sillimanite in that certain of the aluminium atoms have coordination number five, while in sillimanite the corresponding atoms have co-ordination number four.

All three structures are built up around continuous columns of oxygen actahedra which are parallel to the c-axis, and linked laterally by silicon and aluminium atoms, this columnar structure probably accounting for the more or less fibrous growth of all three crystals. The three structures were illustrated in detail, as was also that of mullite. The author discussed the work of Wyckoff, Greig, Bowen, Mark and Rosbaud, and of Hyslop and Rooksby on the similarity between sillimanite and mullite, and showed diagrammatically how the sillimanite structure could be converted into that of mullite.

Nothing was definitely known of the actual details of the features differentiating sillimanite and mullite, but present knowledge was in favour of the suggestion that the equivalence of (SiO_4) and (SlO_4) is the basic idea underlying the relationship.

The results of recent work of A. L. Roussin on the structure of porcelain were described, the fibrous constituent of porcelain, called by Roussin "Porcelainite" being now found to be neither sillimanite nor mullite. The presence of this substance was unsuspected until X-ray methods were applied, and nothing was yet known of its chemical composition.

Studies in Clay Mixtures for Glass Melting Pots, Part IV. The Corrosion Resisting Properties. By J. H. PARTRIDGE, Ph.D., G. F. ADAMS, B.Sc., and J. R. LAIT (Re-

search Laboratories of the General Electric Co., Ltd., Wembley).

In presenting the final part of the investigation on clay mixtures, Dr. Partridge dealt with corrosion-resisting properties of various clays, the degree of solution in molten glass having been determined. The clays were also made into small crucibles, and the quality of glass obtained by their use was examined. The clays used included siliceous and aluminious varieties.

In the experiments in which a specimen of the clay of definite constant size and shape was placed in a refractory crucible and heated with batch and molten glass, the extent of corrosion was measured by the average depth of penetration of the glass, or the decrease in area of the refractory, after a fixed time. The depth of penetration was measured from micro photographs of the cut and polished specimen after treatment. All specimens were fired to 1350°C., the corrosion was carried out at 1300°C. or 1350°C., and the attacking batches were such as were used commercially to produce either a lead-alkali-silica, or a lime soda silica glass of known composition.

It was found that the degree of corrosion of the aluminous clays was less than that of the siliceous, when the lead glass was used, the batch being more corrosive than the glass. Specimens which were corroded least had a white protective layer, consisting mainly of mullite between the glass and the refractory, whereas this was almost non-existent in the case of the more siliceous materials.

In longer tests carried out at 1300°, with the lime batch, it was found that the close-grained aluminous clays resisted to a greater extent than the siliceous ones, the structure of the clay being a very important factor in assessing the resistance.

Generally speaking, the glass from the aluminous clays was more cordy than that melted in siliceous clays, the latter type of crucible giving the best quality glass. The cords observed were of such magnitude as to be of importance only in thin blown ware, optical, and perhaps window glass. It was, however, impossible to remove strain from the very cordy specimens and many cracked, in spite of very slow annealing.

The possible method of the formation of the white layer rich in mullite which protected the aluminous clays against corrosion, was discussed.

MINERALOGICAL SOCIETY.

Tuesday, March 15.

Sir John S. Flett, President, in the chair.

The following papers were read :—

The Distinction of Pyrite from Marcasite in Nodular Growths. By Mr. F. A. Bannister.

X-ray single crystal and powder photographs show that nodules from the Chalk in the South of England are pyrite. Examination of polished sections of a number of these nodules by reflected polarised light confirms this work; in no case of nodular pyrite yet examined is there evidence of an intimate intergrowth of marcasite and pyrite. Both methods have also been applied to the study of nodules from other localities including the true marcasite nodules from Wisconsin, U.S.A., and pyrite nodules in shales. Nodular pyrite is far more common than was formerly supposed whereas nodular marcasite is comparatively rare.

On the Changed Composition of an Anorthoclase bearing Rock-glass. By Dr. L. Hawkes and Dr. H. F. Harwood.

The vitreous contact facies of a felsite dyke contains anorthoclase insets which cannot have grown in a liquid represented by the glass. The glass, which shows no outward sign of alteration and exhibits strain birefringence, has taken up soda and water and lost potash and silica. Glasses are more liable to metasomatic change than crystalline rocks.

The Spherulitic Rhyolites of Jersey. By Dr. A. E. Mourant.

The spherulites present a variety of structures. These are described and their origin is discussed, and particular attention is paid to rhythmic growth of which there are good examples in some of the spherulites.

An Albitite from Ve Skerries, Shetland Isles. By Dr. Frederick Walker.

A specimen collected from this inaccessible group of rocks proves to consist of albite 90 per cent .chlorite (replacing biotite?) 2 per cent., quartz 2 per cent., with accessory titaniferous magnetite and apatite. Texture granitoid. Specific gravity 2.64. Chemical analysis compares closely with those of albitites from the Ural Mountains, and from the Assynt district, Sutherland.

Notices of Books.

CIENCE TO-DAY AND TO-MORROW.

Science To-day and To-morrow. Comiled from a series of lectures delivered at [orley College, London. Pp. 196. Messrs. Villiams and Norgate, 38, Great Ormond treet, W.C. 1932. Price 8s. 6d.

By publishing in book form the lectures :cently delivered by eminent men of :ience at Morley College, Messrs. Williams nd Norgate will bring before a much wider udience these valuable summaries of the iodern tendencies in different branches of :ience. These lectures, or essays as they iay now more appropriately be termed nce they are in book form, are charcterised by great lucidity, although iere is thereby no sacrifice of scientific :curacy nor any "talking down" to :aders less familiar with the subject. In erusing these essays two thoughts in parcular strike the reader. One is the many ays in which the sciences have overlapped ich other in recent years so that most :tention now seems to be centring round ie peripheries where contact is made with ther branches of scientific knowledge. The :her thought which occurs to the reader the necessity of retracing one's steps and ioking at the development of the sciences uring past periods before it is possible to ppreciate the position to-day and the prosects and hopes of the future.

The biological sciences best illustrate the odern tendency whereby knowledge obiined in other fields is utilised in attacking roblems that have presented themselves biologists. Not only is biochemistry an stablished field of its own, but the new biohysics has come to describe the application f physical knowledge to biology.

In botany the modern tendency would :em, as Sir Arthur Hill points out, to be wards a greater economic use of our knowdge of plant life as for instance in cultivatig disease resisting fruits and trees, increasig the yields of cereal crops and the prouction of hybrids possessing desirable ualities.

Discussing the future of medicine, Dr. ane Walker stressed, among other importnt things, the future of the hospitals and ie nation's general health service. She irected attention to the British Medical ssociation's proposals for the General Medical Service and another scheme for a complete State Health Service which, it was felt, is bound to come. In the past medicine has been mainly occupied with the treatment of disease. Its chief concern in the future should be with the prevention of disease.

Anthropology takes its students back to the dawn of time and yet as Prof. G. Elliot Smith concludes, "The rational investigation of human nature should enable us to be better to understand peoples of different origin and tradition and sympathetically to enter into their feelings and appreciate their aspirations. It is hardly necessary to emphasise how much the attitude of anthropology in the future can contriute to the promotion of the welfare of mankind."

Most readers of *The Chemical News* will turn first to the chapter on "Chemistry and Radiation" where physico-chemical science is discussed from the standpoint of (*a*) the structure and activity of matter (including its related "fields"), (*b*) the structure and activity of radiation and (*c*) the reciprocal interactions and relationships of matter and radiation. The essay is mainly concerned with (*c*) and includes an account of photosynthesis and all its implications from the standpoint of radiant energy. From this we are finally led to a consideration of the future of the material universe.

Is it slowly dissolving into a universe of radiation in eternal equilibrium?. Or is the present cosmic process a passing phase in which the universe oscillates and fluctuates from state to state?

J.G.F.D.

Handbuch der Pflanzenanalyse. Edited by PROF. G. KLEIN. Vol. 2, special analysis. Pp. xii+973. Vienna: Julius Springer. 1932. Price 96 marks.

This comprehensive Handbook of Plant Analysis in the compilation of which Prof. Klein has had the collaboration of some score of distinguished specialists, covers the whole field of inorganic and organic analysis of plant products and no method appears to have escaped their attention. The text is fully illustrated with the special apparatus needed for the numerous procedures now adopted especially in the newly developed technique of micro-analysis. There are copious references to original communications and to the standard textbooks and larger treaties on chemical and biochemical

analysis and there is a subject index running into almost a hundred closely printed pages, but there is no author index. The subject is divided into the following sections.

(1) Inorganic substances (*i.e.* the elements kations and anions).

(2) Inorganic nitrogen compounds (NH_4, NO_2, NO_3).

(3) Determinations of ash.

(4) Gas and micro-analysis.

(5) Organic bodies, *e.g.* alcohols, aldehydes and ketones, phenols and quinones, acids, fats and waxes, phosphatides, phylosterine, sugars and other carbohydrates. The whole range of plant analysis has been most carefully covered and this great work becomes really indispensable to the analyst and biochemist.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by permission of the Controller of H.M. Stationery Office and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., price 1/- weekly (annual subscription, £2 10s.).

6,042.—Kali-Forschungs-Anstalt Ges. — Production of potassium nitrate. February 29th.

6,201.—Kali-Forschungs-Anstalt Ges. — Recovery of bromine and bromine compounds. March 1st.

6,571.—Kippe, O., and Klockner-Werke-Akt.-Ges.—Manufacture of calcium nitrate from dolomite, etc. March 4th.

Specifications Published.

368,155.—Margoles, J.—Method of stabilising monocalcic phosphate in its solutions, and its transformation into other soluble phosphates, particularly alkaline phosphates.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

362,297.—Zinc oxide.—Szidon, V., 28, Rue de Naples, Paris.

Zinc residues, such as those obtained in galvanising processes, from foundry operations, or from the use of zinc as a reducing agent, are subjected in the presence of sufficient water to form a slurry to distillation under oxidising conditions with progressive heating to 1000° C. or more. The bulk of the impurities present is thus volatilised or destroyed, leaving a crude zinc oxide which may be purified by volatilisation from remaining non-volatile impurities. Before distillation, the residues may be washed to extract soluble impurities and insoluble matter which remains suspended in the washing water ! in this event, sufficient water for the heat treatment is allowed to remain.

Group Abridgments can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., either sheet by sheet as issued on payment of a subscription of 5s. per Group Volume or in bound volumes, price 2s. each.

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DODOLENE.

529,356.—Chemical substances used in manufactures, photography, or philosophical research and anti-corrosives.—Burrell & Co., Limited, Burrell's Wharf, Millwall, London, E.14. March 9. (Associated.)

AQUADAG.

529,231.—All goods in Class 1 which includes chemical substances used in manufactures, photography, or philosophical research, and anti-corrosives.—E. G. Acheson, Ltd., 40, Wood Street, Westminster, London, S.W.1. March 9. (Associated.)

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529,229.—All goods in Class 1 which includes chemical substances used in manufactures, photography, or philosophical research, and anti-corrosives.—E. G. Acheson, Ltd., 40, Wood Street, Westminster, London, S.W.1. March 9. (Associated.)

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Hydrogen and its Uses

By E. F. ARMSTRONG, Ph.D., D.Sc., LL.D., F.R.S.*

It is a characteristic of many papers read before the Society of Arts that they illustrate the application of the discoveries of science to purposes of utility in the industrial arts. Chemists will remember that it was in these rooms that the meeting convened by Robert Warrington was held on February 23rd, 1841, for the purpose of taking into consideration the formation of a Chemical society, and that its first general meeting to elect officers was held here five weeks later. What progress chemistry has made since that day, how vast are its applications, yet its vitality is as great as ever and the solution of old problems leaves but a greater number of new problems in their stead. This is particularly true of the element hydrogen. In spite of its antiquity as an object of chemical interest, the new problems presented by it to-day are leading to investigations in the very forefront of progress and of the highest importance both to theory and practice.

Hydrogen is the simplest atom, the lightest gas.

The chemists of old used the term spirit or air for what we to-day call a gas; it was not until the seventeenth century had two-thirds elapsed that it was agreed that there existed various elastic fluids other than air. Robert Boyle made ferrous gas (hydrogen) by the action of acids on iron and studied a number of other artificial airs. The invention of the pneumatic trough to collect gases over water is generally credited to S. Hales; however, in spite of the fact that he prepared a number of different gases, he failed to discover their specific chemical difference.

Joseph Priestley substituted mercury for water in the pneumatic trough so enabling the discovery of the soluble gases. Chemistry, in the words of the day, "soared into regions of invisible aerial substances."

The action of dilute sulphuric acid on iron appears to be one of the most ancient of chemical reactions. Paracelsus in the sixteenth century describes how "an air arises which burst forth like the wind." Up to about 1766 hydrogen was specifically distinguished as the *inflammable air from the metals.*

It was Henry Cavendish who measured

* Paper read before the Royal Society of Arts on Wednesday, March 16th. Sir Frank E. Smith, K.C.B., C.B.E., F.R.S., Secretary, Department of Industrial and Scientific Research, in the chair.

the specific gravity of the gas, showing it to be seven times lighter than atmospheric air : he also determined the volume which was obtained from a given weight of the different metals.

History records that it was P. J. Macquer who observed the presence of small drops of water on that part of a saucer which had been "licked by the flame of burning hydrogen" but he did not perceive the great discovery that he might have made, and it was left to Scheele to find the fundamental truth that when hydrogen burns in air it unites with oxygen and leaves nitrogen behind.

The classic work on the composition of water by weight is that of Dumas who inferred from his quantitative experiments that 16 parts of oxygen combined with 2.004 parts by weight of hydrogen, a figure subsequently corrected by E. W. Morley working 52 years later to 2.016.

The now accepted atomic weight of hydrogen (O=16) is 1.008.

The hydrogen atom is held to have a simple nucleus and a single electron which is lost when the atom is positively electrified. The modern theories of the physicist regard all matter as built up of two different kinds of units, one the proton or hydrogen nucleus bearing positive electricity, and the other, the electron, bearing negative electricity. The hydrogen nucleus may be quite without structure like an electron, but the nuclei of other elements have a structure and are probably built up out of hydrogen nuclei and electrons. Protons and negative electrons are the only material units not at present known to be complex.

The following table extracted from Alexander's "Colloid Chemistry" shows the order of size, *i.e.*, the diameter of certain material units expressed in fractions of a millimetre.†

Material Unit.	*Visible In.*	*Order of Size.*
Protons		10^{-9} uu
Electrons		2×10^{-6} uu
Atoms		0.1-2.0 uu
Molecules		0.5-5.0 uu
Colloid Particles	(ultra-microscope)	2-20 uu
Resolvable Particles	(microscope)	over 250 uu
Visible Particles	(eye)	about 10 u

† uu = 10^{-6}mm.
u = 10^{-3}mm.

Such small numbers are at first difficult to conceive, but map reading and the study of a globe has taught us something about the change of scales. J. B. S. Haldane has reminded us that when using a globe measuring sixteen inches round the equator, we have a model of the earth on a scale of 1 in a hundred million, with which it would be correct to say we are quite at home. If we construct a model on the opposite scale of one hundred million to one, the atoms of the common elements will be represented as less than an inch across, whilst molecules of organic substances will be a foot or so long. Even so, the electrons and the nuclei round which they revolve will be too small to see, though their orbits could be marked out just as we mark out railway lines on a map. In childhood we were frightened by the word "million" which is not really such a large number. The morning bath contains 10 million drops of water, we often walk 10 million millimetres during the day, our present troubles, we are told, are due to the fact that imports exceed exports by one hundred million pounds.

When a gas glows it emits light of two sorts, band spectra due to molecules, and line spectra due to atoms. The spectrum in the main depends upon the electrons in the outer ring : it consists of certain sharp lines. It is one of the greatest of our achievements, largely associated with the name of Niels Bohr, that mathematics has been able to invade this field of atomic structure and for hydrogen and also for positively electrified helium to give a complete answer to all the questions connecting the different spectral lines. The discovery that the lines of the spectrum are the differences between the wave numbers or terms caused Bohr to adopt the view that each of the terms corresponds to a stable condition of the atom, and that light is emitted when the atom passes from one stable state to another and only then. In this theory the lines of the

spectrum are due to the various possible *transitions between different stable states*: the brighter lines represent very common transitions.

When light is emitted the electron suddenly jumps into an orbit which is much nearer the nucleus. This process is sudden, discontinuous, at present quite unintelligible, and quite contrary to all previous views about the nature of physical happenings.

Much has been learned by the study of the band spectrum of hydrogen. Mathematical analysis by means of wave mechanics led to the deduction that two stable configu-*rations of the hydrogen molecule exist.* The study of the Raman spectrum of liquid hydrogen led to *similar conclusions* for which experimental verification was in due course provided by the work of Bonhoeffer and Harteck who partially separated the two forms. They are referred to in the literature either as χ and β or alternatively para and ortho hydrogen. Due to the alteration in the proportion of the two forms, the specific heat of hydrogen changes with temperature in a manner which the older theories could not explain: it is possible to observe the equilibrium changes by following the specific heat variations. At the ordinary temperature the respective proportions are 25 per cent. χ and 57 per cent. β hydrogen; at the temperature of liquid air χ is the main constituent while only one *form can exist at the absolute zero according* to theory.

The equilibrium is only very slowly attained at low pressures at liquid air temperature, though it is faster at high pressures. It is rapidly attained in presence of catalysts as for example when the gas is absorbed on charcoal. Pure χ hydrogen obtained in this way remains stable at the ordinary temperature; χ hydrogen has not yet been prepared pure, β hydrogen has the lower specific heat and melts at 13.83°k as against 13.96°k for "ordinary hydrogen." It is being discovered that these two forms of hydrogen have some relation to catalytic activity, indeed it would appear that that the ortho-para hydrogen conversion will afford a new and convenient tool for the evaluation of industrial catalysts used in hydrogenation. Ordinary inactive nickel has a negligible power to convert para hydrogen to the ortho-para mixture, but an active nickel catalyst is able readily to bring about the change to the equilibrium mixture.

The story of the liquefaction of hydrogen *is one of the minor epics* of our science well worthy of being sung by a modern Homer. It is claimed that it was partly achieved by Cailletet and Wroblewski, but Dewar was really the first to succeed in getting it in sufficient quantity to show a definite meniscus. The experimental difficulties were great for the means then available in research laboratories, and those who were frequenters of the Royal Institution in the later nineties will remember the thrill the audience experienced as the new achievements were demonstrated to them in the *historic lecture theatre* by that master and artist—James Dewar. Liquid hydrogen *boils at* -252.5°, *solid hydrogen melts* at -257°.

The subject of hydrogen ion concentration is almost outside the scope of a paper dealing with hydrogen, the element, with which it has no real connection. Yet the term is so often used in connection with industry and with changes which take place in the animal body that it may not be out of place to refer briefly to it.

Water, which is in so many respects a *unique substance*, has a *slight* electrical conductivity even in the purest form in which *it can be obtained and it is*, therefore, said in terms of the hypothesis of Arrhenius to be slightly dissociated into ions of hydrogen and hydroxyl.

$$H_2O \rightleftharpoons H \longrightarrow T + OH +$$

According to the most accurate measurements 1 molecule in 556 million molecules of water is so ionised whilst the concentration of hydrogen ions in the purest conductivity water is 10^{-7} mofecules per litre.

Solutions of salts, acids or alkalis in water are likewise dissociated more or less according to the concentration and in terms of the *modern theory display varying activity* so that it is becoming customary, and it is *probably more strictly correct* to speak of hydrogen ion activity than it is to speak of hydrogen ion concentration.

Since a decrease in the concentration or activity of the hydrogen ion may be used to express an increase in that of the hydroxyl ion, one and the same scale can be used for the measurement of both acidity and alkalinity. Whereas titration of acids and bases measures potential acidity or alkalinity, it is the activity of the hydrogen ions which is *in question* when dealing with the reactions of the biological organism. The *term pH, now so commonly met* with in

biological and industrial literature, was first introduced by Sörensen to express not the direct hydrogen ion concentration but the logarithm of its reciprocal

$$pH = \log \frac{1}{H^+}$$

Deprived of their minus sign whole numbers are thus obtained for pH which have a definite meaning to the initiated

Thus $\frac{n}{100}$ hydrochloric acid has pH 2.02, and $\frac{n}{100}$ caustic soda has pH 12.12, pH, in fact, has nothing to do with hydrogen, it is a mere measure of effective acidity.

Hydrogen measured by atoms makes up some 16 per cent. of the earth's crust though measured by weight F. W. Clarke estimates it at 0.95 per cent. of the crust. In the free state it occurs in natural gas and in some occluded gases, as well as in the gaseous mixture evolved from certain volcanos.

According to Moissan the gases evolved during the eruption of Mount Peleé in 1902 contained no less than 22.3 per cent. of hydrogen.

The chromosphere of the sun consists of incandescent hydrogen as shown by the spectroscope : the gas also occurs in stars and nebulæ.

As hydrogen is constantly being produced by the decay of organic bodies, as well as being liberated as the result of reactions in the earth's solid crust, there is always some in the air : this is estimated, however, at less than 1 part per million.

Hydrogen is not particularly active chemically at the ordinary temperature, but becomes a far more vigorous reducing agent in the presence of finely divided metals. It is also more active in the nascent state at the moment of its birth, but this is definitely not dne to it then being in the atomic condition.

As a reducing agent it displaces a large number of metals from their compounds with oxygen, sulphur, etc. In the world or organic chemistry it plays the part of a moderator, carbon compounds fully saturated with hydrogen being much less reactive than when they contain unsaturated linkages. The experimental methods of effecting reduction in the laboratory are as numerous as they are ingenious : latterly they have been supplemented by the catalytic processes based on the discovery that hydrogen becomes especially active in presence of freshly prepared, finely divided nickel and other metals. These have found far reaching application in industry on account of their cheapness and ease of operation.

The decomposition of water by electricity supplied from a voltaic pile to form hydrogen and oxygen was first observed on May 2nd, 1800 by W. Nicholson and A. Carlisle. H. Davy made use of the new idea in his discovery of the alkali metals and so originated the great electrochemical industry. As pure water has a high resistance, alkali or acid has to be added to increase the electrical conductivity. In technical practice the use of a caustic soda or caustic potash electrolyte is universal since acid corrodes the plant. Oxygen is produced at the same time as hydrogen and most of the early plants were installed to produce it for welding and other purposes : to-day the demand for hydrogen is continually increasing and oxygen has become a more or less saleable by-product.

Whenever pure hydrogen is required its production by electrolysis of a dilute solution of caustic alkali in distilled water is indicated. The largest item in the cost is power and though the distribution of the compressed gas in steel pipes over some miles is feasible, it has not yet proved economic in competition with the manufacture of the gas at the point where it is to be used. One of the prime problems in connection with hydrogen, owing to its lightness, is storage which for any quantity in weight involves large holder capacity. The generation of hydrogen for industrial use from the off peak power of the electricity generation stations which can be supplied at a very nominal cost offers great potentialities and would be even more attractive if this question of storage could be solved.

It is not proposed to describe the electrolytic generation process. The best known cell, both in this country and abroad, is the Knowles Cell of the International Electrolytic Plant Company, who built their first large plant to supply hydrogen for fat hardening at Bromborough in 1912, and have not ceased since technically to perfect their design. Cells have been suggested in which the electrolysis is carried on under pressure, so that the cost of compressing the hydrogen for use in pressure synthesis is saved : if perfected these will have many advantages. Techni-

cal progress largely depends on the opportunity to experiment and as new electrolytic plants continue to be demanded, it is to be expected that the last word has not been said in the reduction of the cost of pure hydrogen by this process.

The use of hydrogen for the inflation of balloons dates in Paris from August 27th, 1783, and in this country from November 25th, 1793. The lifting power is nearly 70 lbs. per thousand cubic feet which compares with 60 to 64 lbs. for helium of commercial purity. The difference appears small at first, but when all the necessary fixed weights of an airship have been deducted from the lifting power of an airship with 5 million cubic feet of gas the remaining life available is at present some 50 per cent. greater with hydrogen than with helium.

The gas for dirigibles must be reasonably free from impurities, and it must not contain even small amounts of any that are detrimental to the life of the containing fabric. It is easier and cheaper to produce hydrogen of high purity than to purify it later. In early days its cost was not of prime importance, but with the larger quantities required the cost has to be studied.

At the beginning the gas was made by the action of sulphuric acid on iron, and we read of 80 tons of iron, together with 190 tons of sulphuric acid being required to fill a captive balloon at the Paris Exhibition in 1878.

The commercial practicable methods of making hydrogen for airships are the electrolytic, the iron contact and the silicon process.

The last is favoured for military purposes because of the small space occupied by the generator, the rapid production of hydrogen and the low capital cost of equipment, though the actual cost of generating hydrogen by it is too high for commercial purposes. It is also used in the navy in preference to compressed hydrogen. Hydrogen is produced by dropping granular ferrosilicon, made in an electric furnace, into a 35-40 per uent. solution of sodium hydroxide solution at 60-80°C. The operating conditions are chosen so as to produce gas at a uniform rate throughout the run.

A special and most interesting application of hydrogen is in connection with the atomic welding arc of Irving Langmuir. The atomic hydrogen welding torch is an arrangement of a jet of hydrogen gas through which an electric current is being sent. The hydrogen molecules are dissociated into atoms by the electric energy and these not only exert great chemical reducing power hut by their interaction give a localised extreme heat suited for reducing and welding most of the refractory metals. The device, so simple in appearance, is the outcome of many years of experiment. Having studied the dissociation of hydrogen molecules for a dozen years, Langmuir found that the recombination of hydrogen atoms to form molecules actually evolved more heat than the combination of hydrogen and oxygen aud that such heat would even melt tungsten. The high temperature of the flame, together with its powerful reducing action and the avoidance of gases containing oxygen and nitrogen render the torch particularly useful for welding not only iron and its alloys but also such metals and alloys as contain aluminium, magnesium, chromium, manganese, etc. Substances of very high melting point such as tungsten can be melted with it: the important uses of tungsten in the electrical industry are based on this flame; indeed the gas filled lamp is the direct result of experiments made for the purpose of studying atomic hydrogen.

(To be continued.)

THE EXTENDED COLLINSIC OF ROCK SALT.

By Hawksworth Collins, B.A. (Camb.).

TABLE XLIX.

Theor. S.G. 15° C.		**2.17**				
Obs. S.G.		2.17	20° Kaye			
		2.15	Kopp			
		2.078	Karsten			
				Na	+	Cl
O.R.	**14.685** =	**0.5449**		(**11.865**	+	**15.085**)
Theor. R.I. 15°C.		**1.5449**				
Obs. R.I.		1.5442	D			
O.R.	**14.685** =			**3.865**	+	**10.82**
M.R.	**4.902** =			**0.97**	+	**3.932**
	5.068 P.					
H.F.	**96617** =			**32747**	+	**63870**
						(abnormal)
	97690 T. 97900					
H.F. aq	**96617** =			**32747**	+	**63870**
	96510 T. 97399					

By the Law of Heat of Formation, *Chem. News*, 1926, cxxxii, 246 and 262.

H.F.		Const.		C.V.		At. Wt.	R.V.		C.V.		O.V.
32747	=	**120**	×	**11.865**	×	23	**11.865**	+	**11.865**	=	**23.73**
56764	=	**120**	×	**13.325**	×	35.5	**15.085**	+	**13.325**	=	**28.41**
63870	=	**120**	×	**15.0**	×	35.5	**13.41**	+	**15.0**	=	**28.41**

(The last line shows that the relative volume of Cl in aqueous solution is 13.41.)

Theor. S.G. of the metal $Na = \frac{23}{23.73} =$ **0.9696**

Obs. S.G. of same $= 0.97$

Troost

By the Law of Magnetic Rotation of electropositive elements. *Chem. News*, 1923. cxxvi, 197.

$$\frac{23}{2 \times 11.865} = \mathbf{0.97}$$

NOTES UPON TABLE XLIX.

28.41 is the Equivalent Original Volume of Cl; *i.e.*, it is the relative volume which an atom of Cl would have had, if it had been solid instead of gaseous in the original state.

The five values under Na are invariable in all substances containing this element. *Also four of the five under Cl are invariable* in all solid substances containing it.

The heat of formation of Cl in a solid compound is always 56764, except in this case owing to the difficulty of keeping the salt entirely free from moisture.

There are two lines starting with the letters O.R., because the optical refractivity is calculated in two ways, first, by multiply*ing the sum of the relative volumes of the* component atoms by n - 1, where n is the theoretical refractive index; and secondly, by adding the discovered optical refractivities of the component atoms.

The theoretical S.G. is obtained by dividing the molecular weight by the sum of the relative volumes between the brackets in the first O.R. line.

The theoretical Magnetic Rotation, 4.902, may appear to be very different from the value 5.068 obtained by Perkin. But his result is not entirely experimental. It is due to experiment combined with calculation, for he multiplied his experimental number by the molecular weight and divided the result by the S.G. It is evident from the experimental values given above, that he may have taken the S.G. to be 2.1. If he had employed 2.17 as the S.G. instead of 2.1, his result would have been

$$\frac{5.068 \times 2.1}{2.17} = 4.902.$$

Even if he did not use 2.1, there are several other small errors that may have entered into his experimental work.

If the weight of an atom of Na be magnified several million times so that it becomes 23 grams, then the volume occupied by it in the free state is 23.73 cubic centimetres. When this atom combines with Cl so as to form Rock Salt, its volume becomes 11.865 c.c., exactly half its original size, and in doing so it evolves 32747 calories.

This extended collinsic gives the complete interpretation of all the experimental data recorded by scientists when a molecule of NaCl is formed from its elements. It demonstrates the numerical connection between the atomic weights, specific gravity of the molecule and of each uncombined element, the refractive index of the molecule, the optical refractivity, magnetic rotaton and heat of formation of each element, also the relative volume of each when in combination and when free. And the results obtained are the same in all solid substances containing Na and Cl.

The structure of an atom of sodium, obtained from some of the above numbers, was given in the *Chemical News*, 1931, cxlii, 164; and also very fully in *Chemical News*, 1926, cxxxiii, 401.

ABBREVIATIONS.

S.G. = specific gravity; O.R. = optical refractivity; R.I. = refractive index; M.R. = magnetic rotation; H.F. = heat of formation (solid); H.F.aq. = heat of formation in aqueous solution; P = Perkin; T = Thomsen; D = Dana; C.V. = change of volume; R.V. = relative volume when in combination; O.V. = original volume, *i.e.*, R.V. of uncombined element.

ARCHITECTURAL ACOUSTICS.

By Paul R. Heyl.*

The scientific study of architectural acoustics is a thing of comparatively recent years. In 1895 Harvard University had just completed the Fogg Art Museum, containing an auditorium which proved almost unusable. The corporation of the university appealed to the scientific staff of the faculty for advice and assistance in the matter, and Prof. W. C. Sabine undertook the study of the case. Two years were spent in the investigation of the questions involved, in the course of which experiments were made in a number of existing and satisfactory auditoriums. As a result, certain fundamental but previously unrecognised principles became clear, which later enabled Professor Sabine to predetermine the acoustic design of the new Boston Symphony Hall.[1]

These investigations of Sabine were the pioneer scientific work in the subject. So completely and carefully were they carried out that subsequent workers, until very recently, have for the most part merely enlarged our knowledge of the acoustic properties of the various materials commonly used in building construction.

Usual Defects of Auditoriums.

The usual defects of auditoriums are three—echo, dead spots, and reverberation. In the usual sense of the term, echo means a definite or articulate repetition of a sound after an interval at least equal to the total duration of the sound that is being repeated, while reverberation means a confused or inarticulate prolongation of the sound. Echo is always a bad feature in a hall; reverberation, on the other hand, is desirable up to a certain point; only in excess is it an evil. Of the two, echo is the more difficult to remove; prevention by foresight in construction, aided by expert advice, if necessary, is the best plan.

Echo.

Echo arises by regular reflection of sound from smooth walls, ceilings, or proscenium arches, just as a mirror may reflect a beam of light without scattering it. If, however, the surface of the mirror be roughened the reflected light will be diffused in all directiins; and if the walls and ceilings of a room be similarly irregular (on a sufficiently large scale) the reflected sound will be scattered, broken up, and its definite or articulate character destroyed. In this case we have what is called reverberation.

The lapse of time before an echo is heard is due to the fact that the reflected sound has travelled a longer path than the sound which comes directly from the source. This difference of path may be such as to cause much mischief. If it amounts to 50 feet or more, the reflected sound of a spoken syllable or note of music may arrive at the ear at the same moment as a later syllable or note which has travelled by the direct path, and so cause confusion.

Generally speaking, auditoriums are less likely to exhibit troublesome echo when their outlines are rectangular. An instructive example of the trouble that may be caused by curved walls is cited by Watson[2] in the case of the auditorium at the University of Illinois, with an approximately circular floor plan and a hemispherical dome. The best that could be done in the way of after-correction of the acoustics of the room was only partly satisfactory. Watson regards the complete cure of such a room as hopeless without "surgical treatment"; that is, straightening the walls.

Smooth, hard-finished walls, such as the usual plastered type, are excellent regular reflectors of sound and are consequently likely to produce echo. It becomes of importance, therefore, to break up such surfaces so as to produce irregular distribution of the reflected sound. This is usually done by coffering in the case of ceilings. Examples of this may be seen in many theatres of modern construction. The ceiling, and in some cases, the proscenium arch, are broken up into depressions about 4 feet square, containing a succession of steps totalling a depth of perhaps 8 or 10 inches. An irregular surface of this character breaks up the reflected sound and distributes it in such a way as to minimise echo, and, in fact, to convert it into reverberation. The dimensions which should be assigned to such coffering are not a matter of taste or accident. If the wave length of the incident sound is very large compared to the size of the irregularities it encounters there will be little dispersive effect produced; and, if very small, the smooth spaces inside the coffering may act as regular reflectors. The size mentioned (4 feet in diameter) is a compromise between the average wave length of the male and the female voice.

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* Of the U.S. Bureau of Standards.

Dead Spots and Sound Foci.

Dead spots and sound foci occur as a consequence of echo-producing conditions. Sound travels through the air as a wave of alternate compression and rarefaction, and if a reflected sound wave is retarded by the proper amount it may happen that the compression of the directly transmitted sound and the rarefaction of the reflected sound arrive at the ear at the same time, neutralising each other's effect and producing a diminution in intensity. If the reflected sound is retarded a little more it may happen that the two compressions coincide, producing an unusually loud sound. The most usual cause of such sound foci, however, is an excessively curved wall or ceiling which concentrates the sound to a focus.

Since dead spots and sound foci arise from the same cause as echo their removal may be brought about by the same treatment. Some care and experience is necessary in order to locate the particular portion of the room which is responsible for the production of a dead spot. Often this can be found only by a cut-and-try experiment, as it is not possible to predict the path of reflected sound with the same accuracy as in the case of light. The reflecting portion once found must be treated in such a way as to decrease its power of regular reflection.

Sabine mentions a case of a theatre, the ceiling of which contained a flat oval panel, to which such trouble was traced. In this case an irregular canopy, oval in plan and slightly larger than the panel, was hung just below it with good effect.

Balconies may require special consideration, especially if low and deep. As a rule, this type of balcony should he avoided, as the sound intensity is sure to be diminished at the rear under the balcony, and may be so low that hearing will be difficult.

Reverberation.

A sound produced in a room is reflected back and forth from walls, floor, and ceiling, a portion being absorbed at each reflection until its intensity is so reduced that it becomes inaudible. Owing to the high speed of sound there may be many such reflections in the course of a single second in a room of ordinary size; and the greater the dimensions of the hall the more prolonged will be the reverberation.

If the walls and ceiling of the room be covered with some highly sound-absorbent material, a few reflections may suffice to destroy the sound. Such a room is acoustically " dead " and undesirable. A little reverberation is necessary to satisfy our established tastes and auditory habit, and the desired amount of reverberation is found empirically to increase with the size of the auditorium.

It is customary, since the pioneer work of Sabine, to define the " reverberation time " of a room (perhaps somewhat arbitrarily and artificially) as the time taken for a sound of specified intensity to die away to inaudibility. This standard intensity is a sound somewhat difficult of reproduction. Fortunately, its use is not necessary in ordinary practice, for in most cases the " reverberation time " can be calculated with sufficient accuracy. The method of making this calculation will be explained later.

Excessive reverberation is an evil because it prolongs unduly each syllable or note of music, causing it to interfere with the next. The ideal conditions for intelligibility of sound are two—each syllable should die away before the next arrives, which in ordinary speech may be, perhaps, one-tenth of a second; and the sound must always be loud enough to be heard.

The first of these conditions can always be secured by providing enough sound-absorbing material in the room. For a small auditorium which can easily be filled by the speaker's voice, this is the most important consideration. For a very large room it may be that the amount of absorption dictated by the first condition is so great that the speaker can not he heard in the back of the room. Since the intensity of the human voice can not be much increased it is necessary to compromise between these two conditions and to permit longer reverberation in larger rooms.

In the case of theatres used for sound pictures this compromise is not necessary, as the acoustic output of the loudspeaker is by no means as limited as that of the voice For such auditoriums there may be employed to advantage a somewhat shorter reverberation time than is desirable for rooms of the same size used for speaking or musical performances.

Broadcasting studios may be equipped with variable absorption, consisting of smooth plaster walls covered with heavy curtains which may be pushed back exposing the wall when more reverberation is desired.

Experience with a number of existing auditoriums of acceptable acoustic quality makes possible the formulation of a table or a diagram in which the acceptable limits of the standard reverberation time are expressed for rooms of different volume, used for speaking or musical performances. And, as mentioned above, large auditoriums used for sound pictures may advantageously be designed for a figure somewhat less than the minimum here suggested.

CALCULATION OF THE REVERBERATION TIME.

As a result of the investigations of Professor Sabine and later workers[2] the reverberation time of a room may be expressed by a formula. Let

t = reverberation time in seconds.

V = volume of room in cubic feet.

s = total area of absorbing surfaces in square feet.

a = average coefficient of absorption of these surfaces.

$A = as$ = total absorption of room.

Then, according to Eyring[2], the following relation holds:

$$t = \frac{0.05V}{-s \log_e (1-a)} \qquad (1)$$

Sabine's formula is simpler, but less accurate. It is:

$$t = \frac{0.05V}{A} \qquad (2)$$

Sabine's formula is sufficiently accurate for most rooms, but where the absorption is excessive and the reverberation time very short Eyring's formula must be used.

Different materials differ considerably in their absorbing powers for sound. The most complete absorber known is an open window. It is theoretically possible that a small amount of sound may be sent back by diffraction from the edges of the window, but this quantity is so small that it is permissible to say that an open window is a perfect absorber. A good absorber of sound may absorb, perhaps, half as much sound as an equal area of open window. In other words, if it may be said that an open window absorbs (or transmits) all the sound that fall upon it, its coefficient of absorption is unity, while that of the material above mentioned would be 0.50.

In like manner, every substance may be said to have its own absorption coefficient. This constant was measured by Sabine for a number of common materials, and later workers have extended the list.

Table I gives the absorption coefficient for several substances. Strictly speaking, these coefficients will vary somewhat with the frequency of the incident sound, and in Table I the values given are for a frequency of 512 (Watson[3]).

TABLE I. SOUND-ABSORPTION COEFFICIENTS.

Concrete	0.015
Glass, single thickness	.03
Marble	.01
Open window	1.00
Plaster	.03
Stage opening (depending on furnishing	0.25 .40
Ventilators (50% open space)	.05
Wood, varnished	.03

Absorption coefficients for a variety of materials have been measured at the Bureau of Standards, and the results, at frequencies ranging from 128 to 4,096 cycles per second, are available upon request. Sound-absorbing materials are frequently changed by the manufacturers, and a printed list is consequently soon out of date.

In Table II there are given values of the total absorption of individual objects for a frequency of 512 cycles per second. The unit of absorption in which these values are expressed is approximately equal to that of 1 square foot of open window.

TABLE II.

TOTAL ABSORPTION BY INDIVIDUAL OBJECTS.

Audience	per person	4.0
Church pews	per seat	.4
House plants	per cubic foot	.003
Seats, upholstered, depending on material and lining	per seat	1.0-4.5
Wood seats, for auditoriums,	do.	.25

As an example of the use of these coefficients let us take an auditorium of 100,000 cubic feet capacity, including the stage opening. There is a wooden floor of 4,550 square feet, a plastered ceiling with the same area, 5,320 square feet of plastered walls, a stage opening of 600 square feet, and 500 plain wooden seats. The coefficients for plaster, wood, and glass being the same to the accuracy requisite for this calculation, no special allowance is necessary for closed doors and windows.

The calculation of the total absorption of the empty room is made as follows, the computations being carried to the nearest integer:

Wood floor	$4.550 \times 0.03 = 137$
Plaster ceiling	$4.550 \times .03 = 137$
Plaster walls ...	$5.320 \times .03 = 160$
Stage opening (no furniture, bare walls) ...	$600 \times .25 = 150$
Wooden seats	$500 \times .25 = 125$
Total absorption of empty room ...	709

For the absorption of the audience we must add $500 \times 4 = 2,000$ and subtract the absorption of 500 seats at 0.25, giving a net addition of 1,875 absorption units, and bringing the total absorption of the room with full audience up to 2,584. The reverberation time, by Sabine's formula, is then :

$$\frac{0.05 \times 100,000}{2,584} = 1.9 \text{ seconds}$$

As the absorption of an auditorium is usually not adjustable to the class of performance to be given, a compromise is necessary, and in this case the mean of the upper and lower curves, about 1.4 seconds, will be a suitable value. This would require a total absorption of

$$A = \frac{0.05V}{t} = \frac{5,000}{1.4} = 3,570 \text{ absorption units.}$$

Since the untreated room with full audience has 2,584 absorption units, there must be added by acoustic treatment 986 units.

The choice of an absorbing material is a question of price and convenience, and sometimes of the space available for acoustic treatment. It should be noted that it is not necessarily the case that materials of the highest coefficient are the most advantageous. Where there is space enough to apply the requisite quantity, a material of low coefficient will give better results than one of higher absorption, due to the more uniform distribution of material. We will suppose that a material of coefficient 0.25 has been adopted.

Assuming plenty of space, our problem is to replace a certain area of wood or ordinary plaster, both of coefficient 0.03, by a material of coefficient 0.25, so as to obtain 986 additional units of absorption. The net coefficient of the acoustic material will be 0.22, and the area necessary will be

$$\frac{986}{0.22} = 4,482 \text{ square feet.}$$

an area which can be contained entirely in the ceiling. In case the ceiling area should not be sufficient, the upper portion of the walls may be treated also. It is not advisable to apply acoustic treatment where it is likely to be damaged by persons passing.

In the above example it will be noticed that all of the added absorption was placed in the auditorium and none on the stage. Experiments conducted by Watson[4] indicate that both speakers and musicians prefer reflecting surfaces about them to intensify the sound while the listeners prefer absorbent material in their neighbodrhood.

It is generally considered that the reverberation time is independent of the positions of the absorbing material and of the source of sound. In general, this statement is true, but there are some important exceptions. For instance, if the absorbing material is placed back under a balcony or in some other place where the sound intensity is low, the absorbing material will not be as effective as if it were placed where the intensity is greater.

There are also cases where between large parallel non absorbent surfaces the sound may be reflected back and forth for a longer time than is to be expected from Sabine's formula. The sound in this case does not resemble ordinary reverberation but may be described as a " flutter," and is heard only when the listener is between the parallel surfaces. Exceptions of this kind are rare, but must occasionally be dealt with.

Planning an Auditorium.

In planning an auditorium we must consider three factors—shape, size, and interior finish.

As stated in discussing echo, the design of an auditorium should avoid curved walls or ceilings. An attempt to introduce such features for their artistic effect is almost certain to be detrimental to the acoustic quality of the room. Auditoriums of a rectangular shape have been the most uniformly satisfactory.

Prior to Sabine's work there was current an idea that there shoult be a certain ratio existing in the dimensions of the room; just what ratio no one seemed to know certainly. Sabine quotes several different recommendations. Modern opinion regards such a ratio as immaterial unless, of course, it be carried to an absurd extreme, such as a very long and narrow room.

The question of size must be determined principally by the purpose for which the room is to be used and not by considerations

of space available or seating capacity desired. True, modern amplifying practice makes it possible to use a very large auditorium for speaking, but the present discussion is limited to the consideration of natural features and characteristics. The alteration of quality and the noise introduced by amplifiers are such that they will require much improvement before they will be acceptable for the rendition of anything in which artistic quality is a prime requisite, and for this purpose unassisted auditoriums will for a long time, perhaps always, be the rule.

Generally speaking, a theatre must be moderate in size, while an auditorium for musical numbers, such as orchestral or choral performances, may be much larger. Such performances usually include several vocal solo numbers and this rather limits the size of the room.

The absorption of the audience, as may be seen from the example worked out in Section III, is usually a large part of the total absorption of the room. Almost any room will have passable acoustic properties with a capacity audience, but with half the seats empty conditions may be much worse. By the use of upholstered seats the absorption of the room may be rendered more nearly independent of the audience.

It has been found by Watson[4] that in the distribution of the absorbing material the best results are obtained if the material is placed entirely in that portion of the auditorium occupied by the audience, while the wall and ceiling around the stage are left untreated.

Experience with existing auditoriums leads to an empirical rule connecting the volume of the room with the maximum number of orchestral instruments suitable. This rule is expressed in Table 3. No distinction is here made between wind and string instruments, which are supposed to be present in balanced quantity.

In case the orchestra is reinforced by the organ, due allowance must be made. The new music room at the Library of Congress is a case in point. Its volume is about 100,000 cubic feet. At the opening concert there was present an orchestra of 26 pieces, which, with the organ, produced an excessive reverberation perceptibly spoiling the effect of sudden pauses after a loud chord. The indicated limit for this room is, perhaps, 12 or 15 pieces with the organ.

As to interior finish, this should be planned with both echo and reverberation in mind. A liberal use of coffering on ceiling and sloping upper walls should effectually prevent echo from this source.

Volume of room (*in cubic feet*)	Number of *instruments*
50,000	10
100,000	20
200,000	30
500,000	60
800,000	90

Bibliography.

1 Sabine, W. C., Collected Papers on Acoustics, Harvard University Press; 1922.

2 Eyring, C. F., *J. Acoustical Soc., Am.; January, 1930.* Schuster and Waetzmann, *Ann. der Physik*, March, 1929, p. 672, where additional references are given.

3 Watson, F. R., Acoustics of Buildings. John Wiley & Sons, New York; 1928.

4 Watson, F. R., *J. Am. Inst. Architects; July*, 1928.

Washington, September 4, 1931.

Received March 7th, 1932.

BIBLIOGRAPHY OF BIBLIOGRAPHIES ON CHEMISTRY AND CHEMICAL TECHNOLOGY.

The National Research Council Washington, D.C., announces the publication of Bulletin 86, which is the Second Supplement to the Bibliography of Bibliographies on Chemistry and Chemical Technology covering the period 1929-1931. The original Bulletin (No. 50) covered the period 1900-1924 and contained about 10,000 bibliographies classified under 2,400 headings. The First Supplement (No. 71) covered the period 1924-1928 and contained about 4,000 bibliographies under 1,050 headings. The Second Supplement (No. 86) covers the period 1929-1931 and contains approximately 3,300 bibliographies under 950 headings.

As the title indicates, the work (as in the case of Bulletins No. 50 and 71) is a compilation of bibliograpbies published as separates, or at the end of books or magazine articles, or as footnotes to the same, on the numerous aspects of pure and applied

chemistry. Each entry gives name of author or compiler, title, and place of publication. The majority of the entries state that the number of references, thus giving an indication of the completeness of the particular bibliography. The entries are classified under the proper subject-headings, alphabetically arranged. The duplication of individual entries has been largely avoided by the liberal use of cross references.

As an example of the value of this compilation, the following information is given regarding the number of bibliographies reported in Bulletin No. 86 for some of the more important topics :

Biochemistry 32, Blood chemistry 75, Carbohydrates 29, Ceramics 18, Coal 16, Colloids 30, Cement and Concrete 35, Fats 33, Fertilisers 34, Foods and Feedingstuff 49, Hormones 31, Iron and Steel 90, Metabolism 72, Milk 44, Paper 35, Petroleum 65, Plant chemistry 39, Rubber 35, Soils 76, Vitamins 41, Water 33.

The National Research Council, by the continuance of this service, has made available to workers in chemistry and associated fields, a work that should conserve much valuable time in reference hunting.

ESSENTIAL OIL ANALYSIS METHODS STUDIED IN FRANCE.

The Central Syndicate for essential oils and aromatic raw materials is actively interested in national and international unification of methods of essential oil analysis and in creating in France an independent analytical laboratory and with this view appointed a commission to study the subject. The commission recently reported its conclusions which are as follows : the necessity for drawing up a compendium including all known essential oils indicating the limits of variation of their principal constituents; the desirability of establishing specifications for general application for determining each physical feature and chemical mixture; the need for international standardisation of processes; the value of documentation and of centralising information relating to the essential oil industry and the necessity for organising representatives of essential oil interests in each country preparatory to international convention.

THE BRITISH ASSOCIATION OF CHEMISTS.

Annual Dinner of the Manchester Section.

The dinner was held at the Engineers' Club, Manchester, on Wednesday, March 16th, at 6.30 p.m. Mr. E. N. Marchant, Chairman of the Section presided and in his opening remarks alluded to the increasing influence of the Association. Those who observed the Association closely, said Mr. Marchant, could not fail to notice the great strides that it had made particulary during recent years. There was no direction in which its activities had not developed in a surprising manner. It was quite clear to him that the science of the future was going to take an increasing part in the direction and control of industry. Such an idea had been in the minds of those who had organised the Whitley Councils. It was the business of the Association to keep this question in mind since it had now and in the future would have increasing responsibility in the organisation of industry.

Phenomenal Growth of the Association.

Mr. C. B. Woodley, General Secretary, said that he would like to remind them that during the past year when the depression was at its worst, the Association had elected 220 new members. (Applause) . He had every reason to believe that they would do at least as well as this this year.

Increasing Strength of the Unemployment Benefit Fund.

Members might further be interested to know that since its inception the fund had paid out £7,500 in benefit. In these difficult times when even chemists who had occupied remunerative positions sometimes found it difficult to obtain suitable employment, the fund had become of greater importance than ever. But in spite of the fact that benefit payments steadily increased, the reserve fund was growing in an extremely satisfactory manner. (Applause.).

Growing Activity of the Appointments Bureau.

1,000 appointments had been notified through the Bureau during the year ending March, a very large increase on previous figures, and the number of employers who approached the Bureau direct had increased in a surprising manner. It was being discovered that the Association could nearly

always supply the right man for the right post, and it might be said in general that an employer could always obtain better results with much less trouble by application to the Bureau than any obtainable by advertising.

The Legal Aid Department remained very active, in spite of the fact that fortunately, there had been no recent court cases. As an example of what he meant he would inform them that a member by negotiation through the Department had obtained £500 compensation he would not otherwise have had. This was only one example.

Dr. Callan, Secretary of the Manchester Section, Society of Chemical Industry, said that he was extremely interested in the work of the Association. He thought personally that the work the Association was doing was essential for the profession but that it was not realised even now, among a large number of chemists, exactly what the Association did do. He thought that even more publicity regarding the economic aspect of the Association's work would result in securing as members a large number who, as he said, were really ignorant of its work. He would like to add that he had greatly appreciated being invited that evening.

Mr. S. R. Price, President of the Association, said that it was a great pleasure to be present at a dinner of a local section whose activity—evidenced by its increase in membership—was obviously being energetically and wisely directed. The Association existed for the betterment of the professional chemist, and they could judge from what they had heard that evening how successful its efforts had been. But that was not enough. We had to organise and prepare for the future. The depression would pass and times of prosperity were ahead. It was then that the profession of chemistry would come into its own, and the Association would have to see to it that the very most was made of every opportunity. (Applause.)

Mr. F. Scholefield, Past-President of the Association, said that it was a great pleasure to welcome the guests that evening Mr. Lester, Chairman of the local section of the Institute of Chemistry, and Dr. Callan, Secretary of the local Section of the Society of Chemical Industry. (Applause.) It was also the great pleasure and privilege of the Association to welcome Mr. W. E. Kay, whose pioneer work for the B.A.C. had done so much to place the Association in the place it occupied to-day. (Applause.) He would like to repeat again here what he had often said before, that the most friendly relations existed between the Association and other societies. He thought that it could not be too widely known that the Association did not seek to compete with the Institute of Chemistry. It had different functions, and ones which could be carried out by no other society. It carried out those functions extremely well and for that very reason had neither the time nor the wish to compete with other societies. But the Association was always ready and desirous of co-operating with other societies in any matter likely to be of common interest to all.

Mr. Gill proposed the artistes and pianist who provided an excellent entertainment during the evening.

THE NEW PRESIDENT OF THE FEDERATION OF BRITISH INDUSTRIES.

Sir J. George Beharrell.

Born at York in 1873, Sir George Beharrell was educated at Almondbury, Yorks, and Leeds University. Entering the service of the North Eastern Railway, as it then was, he became assistant to the General Manager, and Assistant Goods Manager and Commercial Agent.

His great knowledge of Railways and Commercial transport led to various appointments of high importance during the war. After a short period as Director of Statistics and Requirements at the Ministry of Munitions, he proceeded to France as Assistant Director General of Transportation. Later he became Assistant Inspector of General Transportation for all the theatres of war with the rank of Lt.-Col. In 1917 he received the D.S.O.

Towards the end of the war he became Director of Statistics at the Admiralty, and was attached to the Geddes Committee on National Expenditure in 1921-1922.

Sir George received his knighthood in 1919, and from 1919 to 1922 was Director General of Finance and Statistics at the Ministry of Transport.

For two years he filled the office of President of the Society of Motor Manufacturers, and for one year President of the India Rubber Manufacturers Association. He is now Managing Director of the Dunlop Rubber Company, Ltd., a Director of Imperial Airways, and a Vice-President of the Federation of British Industries.

FORMATION OF A BRITISH CHINA CLAY ASSOCIATION.

At a meeting held at St. Austell, Cornwall, on the afternoon of the 18th March, at which representatives of practically all the China Clay Producing Companies were present, it was unanimously decided immediately to form an assoeiation representative of the British China Clay Producers.

This meeting was convened by the Federation of British Industries at the request of the trades concerned, owing to the fact that there was no organisation in existence which would enable the China Clay Industry to talk with a single voice. It was not suggested that the proposed association should deal with such questions as general price control, or matters affecting the domestic policy of any of its associated concerns. The primary object of the association will be to enter into negotiations with the French National Association of China Clay Producers in order to consider possible means of obviating the fixing of a quota by the French Government on the imports of China Clay, which, it is understood, the French Government is contemplating doing.

U.S. BANKER NEW HEAD OF "COSACH."

Medley G. B. Whelpley of New York has arrived at Santiago to become the new president of the Cosach nitrate group, the $300,000,000 government production organisation controlled by American interests, and began immediately his task of finding a solution for the troubled condition of the industry.

He planned to begin as soon as possible a series of conferences with the Finance Minister of Chile, Izquierdo, with the hope of working out some formula which would be satisfactory to both the producers and the government.

There has been a popular demand for a dissolution of the nitrate group in recent months. A steady decline in world sales of natural nitrate because of the general financial situation as well as synthetic competition also adds to the problem the new president is called upon to solve.

BEESWAX EXPORTS FROM CUBA INCREASED IN 1931.

An appreciable gain in the quantity of beeswax shipped from Cuba was registered in 1931, although price decline was reflected in the lowered value of total exports.

DOMINICAN REPUBLIC PREFERENCE FOR PAINTS.

The colours of paints having the best demand in the Republic are, in the order named, white, blue, black and green. Retail prices of interior paints ranged from $2.25 to $2.50 per gallon, whereas exterior paints were sold at $2.40 to $4.00 per gallon. For floor paints, light and dark grey, as well as terra cotta are preferred for cement or wood floors. A dislike has developed on the part of the public for maroon and dark brown shades for floor paints to an extent that some retailers have refused to stock these particular shades. For high-grade floor paint the retail price is approximately $4.00 per gallon.

GERMAN POTASH EXPORTS DROP 33% IN VALUE—38% IN QUANTITY.

German potash sales in 1931 amounted to 963,819 metric tons of K20, a decrease from 1,401,407 tons in 1929. The decline is attributed to the agricultural crisis in Germany and other countries causing farmers to curtail expenditures generally and economise in the consumption of fertiliser materials. Growing production in other countries doubtless also exerted an adverse influence in restricting sales in certain foreign markets. Sales fell off in both the domestic and foreign trades but the greatest contraction by far ocurred in exports, which decreased by about 33 per cent. in value and about 38 per cent. in quantity in 1931 from the level of 1930. Sales in the domestic market declined only 15 per cent. from the preceding year.

ITALIAN DYE INTERESTS JOIN INTERNATIONAL DYE CARTEL.

The Italian dye firm "Azendi Colori Nazinale Affini," with a capital stock of 60,000,000 lire divided in the proportion of 51 and 49 per cent. between the Italian Montecatini and the German I.G., is reported to account for 60 per cent. of the Italian dye production. The controlling interest of another important producer, the Societa Chemica Lombarda, A. E. Bianchi & Co., is held by the I. G., and the balance by the Montecatini. It is reported that the Italian dye industry is now a party to the German-French-Swiss dye agreement. Details of the agreement, however, are not available.

Proceedings and Notices of Societies

THE PHYSICAL SOCIETY.

March 18.

The following papers were read :-

The First Spark Spectrum of Arsenic (As II). By A. S. RAO, M.A., M.Sc.

About 70 lines belonging to the spectrum of As II have been identified as due to combinations between the deep terms of the singlet and triplet systems. A provisional term scheme is set up, based on two members of the singlet series, $5s^1P - mp^1D$. The largest term $4p^3P_0$, $\nu 162788$, leads to an ionisation potential of about 20.1 volts.

The Photographic Measurement of the Absorption Coefficients of Gamma-rays from Radium (B+C). By J. S. ROGERS, B.A., M.Sc., F.Inst.P., Senior Lecturer in Natural Philosophy, The University of Melbourne.

In continuation of earlier work in which the photographic action of γ-rays was examined, the absorption of the γ-rays from radium (B+C) filtered by 1.6 cm. of lead has been measured by a photographic method. With this lead filter the absorption is exponential. The absorption μ_e per electron for the lighter elements is found to be constant, in accordance with the Klein-Nishina formula; and the value, 1.56×10^{-25}, corresponds to a wave-length of 7.0 AU. The increase of μ_e for the heavier elements in excess of this is found to vary as z^3, so that the additional absorption is assumed to be due to the photoelectric effect. It has been found that, by assuming the photoelectric term to vary as $\lambda^{2 \cdot 2}$, an approximate agreement is obtained with the absorption of short X-rays. The intensity of the main γ-rays in the radium (B+C) spectrum after they have passed through 1.6 cm. of lead is calculated by assuming the $\lambda^{2 \cdot 2}$ law, and it is shown that the intensities are not in contradiction to an effective wave-length of 7.0 AU. It is shown that the use of limiting channels between the source and absorbers causes scattered, softened γ-rays to be superposed on the main beam.

On the Derivation of Maxwell's Equations from the Equations of the Quantum Theory. By M. FAHMY.

In a theory developed by Flint and Fisher the fundamental equations of the quantum theory are expressed in terms of a five-dimensional geometry based upon the use of two inter-related tensors A and B. In the present paper Maxwell's equations are derived from the five-dimensional equations previously proposed, and the tensors A and B are exhibited as geometrical quantities related to the electromagnetic potential.

THE OPTICAL SOCIETY.

At a meeting of the Optical Society held in the Imperial College of Science, South Kensington, on Thursday, March 10, a paper upon the *Absorption of Light.* By R. A. HOUSTOUN, M.A., D.Sc., was read.

The intensity of a beam of light at a point in an absorbing medium decreases exponentially as the distance travelled. The law is sometimes known as the Bougwer-Lambert law. It holds only for monochromatic radiation, and the ratio of the intensities at two given points is independent of the absolute intensity. This independence might be expected to break down when the intensity is very great for two reasons. These two reasons are explained in the paper, and though very speculative they promoted the author to look into the experimental proof of the law.

The experimental proof is found to be surprisingly slight.

A Note on Refractive Indices. By MRS. E. GIFFORD.

An interesting comparison between the refractive indices and dispersions of certain glasses is made with those of certain specified liquids.

A demonstration was given by Mr. W. E. Watson Baker, of Messrs. W. Watson and Sons, Ltd., of the manufacture of a microscope.

The demonstration was illustrated by a remarkably good ciuematograph film, showing all the important mechanical operations involved in the construction of the slides, etc., and in the grinding and polishing of the lenses.

Another interesting demonstration was given by Mr. C. Dunbar, of the National Physical Laboratory, upon the *Measurement of Particle Size and Cencentration in Opal Glasses.*

ROYAL SOCIETY OF ARTS.

COMPETITION OF INDUSTRIAL DESIGNS, 1932.

By kind permission of the Governing Body of the Imperial College of Science and Technology, the public exhibition of works sent in for this year's open Competition of

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New Patents.

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Latest Patent Applications.

6,870.—Boake, Roberts & Co., Ltd., A. — Manufacture of Phenolic antiseptics. March 7th.

7,207.—Distillers Co., Ltd., and Stanley, H. M.—Manufacture of ethyl alcohol. March 10th.

6,926.—Dreyfus, H.—Treatment of carbohydrates. March 8th.

7,118—7,19.—Dreyfus, H.—Manufacture of aliphatic compounds. March 9th.

7,120.—7,121.—7,122.—Dreyfus, H. — Manufacture of organic compounds. March 9th.

Specifications Published.

368,298.—Royer, E.—Apparatus for producing ozone.

368,675.—Akt.-Ges fur Stiekstoff-Dunger.—*Manufacture of calcium carbide.*

Abstract Published.

363,347.—Calcium sulphate.—Crundall, S. F. W., Llewellyn, I. P., and Spence and Sons, Ltd., P., National Buildings, St. Mary's Parsonage, Manchester.

Finely divided and apparently amorphous calcium sulphate is obtained by treating suitable calcium compounds other than the sulphate, for example, the mineral or precipitated carbonate, or the oxide or hydroxide with sulphuric acid, with or without sulphates such as alkali sulphates or bisulphates, in such quantity that excess of free acid remains after completion of the reaction, and of a strength insufficient to effect any solution of the calcium sulphate. Thus, sulphuric acid of specific gravity 1.75 is rapidly added to calcium carbonate in 35-40 per cent. excess over that required for neutralisation. Alternatively, a lower excess of oleum or R.O.V. may be added. The acid should preferably be in excess from the commencement. Excess acid may be removed by washing, followed if desired by treatment with an alkaline solution, or suitable alkaline earth, as barium hydrate.

526,089.—A diamond label device bearing

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The Latest Trade Marks

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ERINOL.

528,380.—Synthetic resin intermediates, being chemical substances for use in manufactures.—Erinoid, Ltd., 58, Coleman Street, London, E.C.2. March 16. (Associated.)

528,088.—A diamond label device bearing the word INSPRO.—Chemical substances used for manufactures, photography or philosophical research and anti-corrosives.—Inspro Prodncts, Ltd., King William House, Eastcheap, London, E.C.3. March 16th.

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DETERMINATION OF EMULSION TYPE

By R. M. WOODMAN.

Three main methods of determination of emulsion type are in general use: the indicator method, where indicators[1] such as Sudan III or potassium permanganate[2], insoluble in one phase, are used; the drop test (the most usual test), first suggested by an observation of Pickering[3] and worked out by Briggs[4], the criterion being mixing or non-mixing of a drop of emulsion when stirred with water; the electrical conductance method suggested by Clayton[5], based on the fact that an oil external phase will not conduct electricity.

These methods are useful for quick determination of type; but other tests and observations are often surer where the emulsion, in whole or in part, is stable for some time. The author has had occasion to use the following methods which he has noticed during his work[6].

(1) The direction of creaming of an emulsion; for oils less dense than the aqueous phase this should be upwards for OW, and downwards for WO types, and *vice-versa*.

(2) (*a*) The volume of cream so formed on standing (in a wholly stable emulsion) immediately defines the type if the initial phase volume ratio differs greatly from unity (in which latter case either type would give the same volume of cream). (*b*) The volume of the clear underlayer or supernatant layer of a fully-creamed emulsion.

(3) Drop tests in water and in oil.

(4) Drop tests on the cream or on the stable portion of an aged emulsion in water and/or in oil (assumes the stability of at least a portion of the emulsion).

(5) The viscosity of the emulsion or of the cream as judged by eye, and by the "feel" and "swish" on shaking (this depends to a large extent on the relative viscosities of the oil and aqueous phases).

(6) The "mayonnaise" method, *i.e.*, additions of one liquid phase to an emulsion with reshaking; increasing viscosity* proves that the added phase is the disperse phase and *vice-versa*. (N.B.—An abrupt change of viscosity to a more fluid system after one of the additions might signify breaking, which can easily be perceived; in a system yielding dual types, it might, of course, signify inversion).

(7) The relative volumes of the liquids obtained by cracking the cream from a fully creamed emulsion will define the type.

* This test is very sure when complete emulsification obtains; the presence of free disperse phase (owing to incomplete emulsification) tends usually to make the system very fluid.

(8) The character of the clear or nearly-clear liquid underlayer or supernatant layer of an emulsion cream as ascertained by drop tests—whether oily or aqueous—defines the type, for this is the excess continuous phase of a perfect emulsion. (With some emulsions, where a little oil only is stably emulsified, test 8, like tests 1, 2(a) and 2(b), may lead to an erroneous conclusion, as immediate drop tests in water (test 3) may tend to do).

(9) The arrangement, on ageing, of the three portions of a cracking emulsion when the two clear (or nearly clear) phases and some emulsion are all present; the continuous phase as a rule is clearly demarked, whilst the cracked disperse phase is often small in quantity and definitely appears to be separating out from the emulsion portion.

(10) The tendency of the emulsion portion of an incomplete or cracking emulsion to cream (this shown often by a thin rim of cream at the top or bottom of the emulsion portion, depending on type and correlated with the density of the non-aqueous phase; or, alternatively, by the gradation in the turbidity of the emulsion portion).

(11) The appearance (*e.g.*, colour, oiliness, smoothness, etc.; in the case of two transparent phases such as water and phenol little can be told by this method).

(12) When an emulsion is, or becomes very coarse-grained, separate minute globules of the disperse phase are often noticed in the other phase; in this case, and often when an emulsion breaks very rapidly, the dispersed phase masses itself together in large part as separate globules of varying size which are reluctant to coalesce for hours or days, the mass of free disperse phase globules occupying the position which a cracking cream would occupy.

(13) When a cracked emulsion leaves a kind of " skeleton work " of turbid films, often where the cream would have been.

(14) During the preparation of an emulsion by previous gentle partial rotation or feeble shaking[6], the tendency for one phase to be the dispersed phase is shown by that phase forming small globules in the future continuous phase.

Some of these indications are sure, others appear very slight; but even the slightest indication of type must be accepted in some difficult cases, and cumulative verifications of type are at all times desirable.

It has been demonstrated previously[6] that drop tests, etc., made on emulsions immediately following preparation may be misleading. The surest tests seem to be drop and other tests and observations carried out on the cream, apparent cream, or uncracked portion of emulsion.[6] Fortunately most emulsion systems last sufficiently long, in part at least, to allow of these being made; in other cases the cracking is so rapid that immediate drop tests only are possible, and the determination of type must rest solely on the judgment of the experimenter concerned, and can never, probably, be put to conclusive tests.

Thus, with simple one-type systems, a portion of the emulsion at least is usually stable long enough to allow some of these observations to be made; in a system where dual types occur, however, sometimes one type is imperfect and very unstable,† and hence immediate tests and the limited observations which can be made may be liable to yield wrong interpretations.

Some of the following experiments will illustrate this and other points; others are devoted to a more thorough re-examination

† Woodman and McK. Taylor: *loc. cit.* Both types, however, are stable in the systems oleic acid-bentonite-water, etc., at certain phase-volume ratios. At phase-volume ratios common to both types, it should be carefully noticed that subsequent re-shaking of one of the aged types always caused inversion to the other, so that by stability is implied here stability as long as subsequent mechanical treatment is avoided. A curious example may make this meaning clearer (Woodman: *loc. cit*): 10 c.c. of 0.4 per cent. aq. gelatine and 10 c.c. of cresylic acid can be made to give, at will, by different mechanical treatments, the two types OW (imperfect, and unstable on keeping), and WO (perfect and stable). On ageing, the OW cracks entirely and the OW creams upwards to give a stable cream; subsequent re-shaking in any manner of either aged type, however, always gives the unstable OW, which hence, in a restricted sense, can be labelled the " stable " type. Apparently, in dual systems at the common phase volume ratio, therefore, two kinds of stability must be noted: (*a*) stability in the ordinary sense that the emulsion does not crack on standing, and (*b*) stability to subsequent mechanical treatment.

of certain systems where dual types have been found to occur, and to examples of doubtful type-determination due to precipitation of emulsifier.

The first experiments were repetitions of some "key" experiments of former work.[6]

System oleic acid — 1 per cent. aq. bentonite suspension :§ *Emulsion* 1 :— (24 hr.). 15/5 : IVS→perfect OW (IT aq. and oil). Rather coarse-grained as before. Creamed up, cream being rather coarse-grained but stable. Cream tested after 14 days by drop tests and found OW. Therefore emulsion definitely OW(P.s.S.).

Emulsion 2 : (24 hr.). 5/15 : GPR→perfect WO (IT aq. and oil). Tended to cream down very slowly; cream was stable and, after 11 days, the lowest portions of the cream were tested by drop tests and found WO. During GPR, the aqueous phase was seen to split up in the oil. The emulsion was, therefore, definitely WO(P.u.S.).

System "acid" linseed oil[6]*—1 per cent. aq. bentonite suspension* : *Emulsion* 3 :— (25 hr.). 15/5 : IVS→perfect OW (IT aq. and oil). Rather coarse-grained; creamed quickly upwards to a coarse-grained cream which was OW by drop tests. This cream was breaking in 3 hr. OW(P.s.U.).

Emulsion 4 : (25 hr.). 5/15 : GPR→perfect WO (IT aq. and oil); during GPR, water formed small globules in oil. Creamed down quickly, cream being WO by drop tests. Re-shake after 2 hr., and get much stabler[6] emulsion and undercream, which is definitely WO.

System olive oil—1 per cent. aq. bentonite suspension : *Emulsion* 5 :— (25 hr.). 15/5 : IVS→perfect OW (IT aq. and oil); creamed up to partially stable OW cream (tested) over thin OW emulsion (tested). Therefore definitely OW(P.s.).

Emulsion 6 : (25 hr.). 5/15 : GPR→perfect WO (IT aq. and oil). In two hr. creamed down, the cream nearly breaking during the process (giving free water), so that it could not be tested by drop tests. The skeleton structure of WO cream was, however, still apparent as a kind of rough network.

System linseed oil—1 per cent. aq. suspension of hydrogen bentonite : *Emulsion* 7 :— (120 days). 15/5 : IVS→perfect OW (IT aq. and oil); creamed up, the cream being stable and OW after 24 hr. OW (P.s.S.).

Emulsion 8 :— (120 days). 5/15 : IVS→perfect WO (IT aq. and oil); creamed down slowly to give a stable cream which was tested after 24 hr. and found WO. WO (P.u.S.).

System linseed oil—1 per cent. aq. suspension of hydrogen clay from Rettendon clay subsoil[6] : *Emulsion* 9 :— (117 days). 15/5 : IVS→OW which creamed up immediately; traces of free oil. The cream by drop tests was OW, though creaming took place even during drop tests in water. This quick-creaming was due to the emulsion's being coarse-grained (the disperse phase globules could be seen, fairly regular as regards size and shape).

Emulsion 10 :— (117 days). 5/15 : IVS →perfect WO (IT aq. and oil). In 20 hr. had creamed down and, though some cracking had taken place, the remaining cream looked stable and gave OW tests.

The results of tests carried out on aged emulsions (1-10) demonstrated that the findings got by immediate drop tests were correct and that the clays used promote dual types of emulsion with certain oils.[6] This is the general experience in emulsion work, and any departure from it usually arises from incomplete emulsification and/or instability of the emulsion, as previously pointed out.

In the case of emulsification of the

§ The following abbreviations are used in the text : *the age in hours or in days in parenthesis is the age of the emulsifying medium at the time of experiment; the ratio represents c.c. aq. phase to c.c. of oil phase employed;* IVS *(immediate vigorous shaking) and* GPR *(gentle partial rotation or very feeble shaking, followed by vigorous shaking) are methods of preparation previously discussed*[6]; OW and WO denote oil-in-water and water-in-oil types of emulsions, respectively; IT aq. and oil denote that drop tests in water and in oil were made immediately on the freshly-prepared emulsions; P = perfect emulsion on preparation; FO = free or unemulsified oil present; CG = coarse-grained emulsion; S, SU, U, and VU = stable, slightly unstable, unstable, and very unstable emulsions, respectively, as judged on ageing; s = creams, or tends to cream or to clear upwards; and u = creams downwards to form an undercream, or tends to cream or to clear downwards.

phenols and hydrogenated phenols with clay suspensions, however, the results are more indefinite, and the placing of the emulsion in one or the other type is often a matter of the experimenter's personal judgment, because many of the emulsions are incomplete and very unstable, immediate and often unsatisfactory drop tests alone being possible.

Neither would the electrical conductance test be of use with incomplete or unstable emulsions, for the simultaneous presence in mass of both liquid phases would affect the conductance. Nor would dusting the surface of such an emulsion with an indicator be of any use—the usual test for type with a solid indicator is to see if the colour from the indicator dust spreads through the continuous phase or not—because (*a*) such an emulsion would present both liquid phases in mass, and (*b*) if some incomplete emulsions such as were obtained[6] with aqueous lecithin dispersion and toluene were tested by dusting, the conclusion—erroneous as with immediate tests—would be that the supernatant free oil (coloured red with Sudan III) was excess continuous phase.

In the following experiments an indicator was actually shaken with the two liquid phases. (It should be remembered, however, that the addition of indicators to emulsion systems complicates matters, as indicators may be emulsifiers themselves). Potassium permanganate was found useless in this respect, for, on shaking a dilute aq. solution with cresylic acid, decolorisation was effected and a flocculent material precipitated. Therefore very dilute phenol and hydrogenated phenol solutions of a trace of Sudan III (the solutions looking like red ink) were used as the oil phase.

System coloured cresylic acid—1 per cent. bentonite suspension: *Emulsion* 11 :—(48 hr.). 15/5 : IVS⟶OW (IT aq.). The emulsion had a pinkish look and creamed down. The cream was slightly unstable, but after 24 hr. still gave OW drop tests. OW (u.SU), definitely.

Emulsion 12 :— (48 hr.). 5/15 : IVS⟶WO? (IT aq.). The emulsion had a scarlet look (oil continuous phase?), and quickly broke at the top, about 1 c.c. of water collecting at the surface in 10 min., the remainder of the emulsion being scarlet; this layer of free water retained a globular structure to some extent. In 15 min. colourless points (water globules) had appeared in the red bulk of the emulsion: these tended to rise to give a thin layer of tiny water globules under the free water layer, some coalescing with this water layer.

Definite determination of type was difficult here, if not impossible. The author has previously quoted this ratio as giving a very unstable WO type.[1]

System coloured phenol—1 per cent. aq. bentonite suspension: *Emulsion* 13 :—(144 hr.). 15/5 : IVS⟶OW (FO.IT aq.). Pinkish chalk-like appearance confirmed this. Creamed down, cream being slightly unstable but OW by drop tests. Therefore definitely OW (u.SU.).

Emulsion 14 : (145 hr.). 5/15 : IVS⟶WO? (IT aq.). Red appearance (oil the external phase?). More lasting and finer-grained than 12, but broken in an hr. WO (VU)?

Emulsion 15 : (145 hr.). 10/15 : IVS⟶no emulsion, but a mere mixture. Very coarse grained globules of phenol settle out quickly, so that evidently a very coarse dispersion of phenol in water is temporarily formed. As 13 is definitely OW, and as 14 is much more like an emulsion than 15, it might be argued that 15 is near the inversion point, 14 in all probability then being a WO by cumulative evidence.

System coloured hexalin—1 per cent. aq. bentonite suspension: *Emulsion* 16 :—(168 hr.). 15/5 : IVS⟶OW (IT aq.); FO. This emulsion was light salmon in colour. In an hour it had creamed up, the cream, which was breaking, giving OW tests. In 24 hr., the emulsion was broken, but the supernatant oil layer still possessed a granular structure, looking like a reticulated network with films of aq. phase separating the globules of oil. OW(U), definitely.

Emulsion 17 :—(169 hr.), 5/15 : IVS⟶WO? (IT aq.). Redder than 16 (WO?). CG. and very stiff (hexalin is very viscous, and hence this pointed to an oil continuous phase). Tendency to cream down (WO?), but very unstable. WO (VU)?

System coloured methyl-hexalin—1 per cent. aq. bentonite suspension: *Emulsion*

[1] Woodman and McK. Taylor: *loc. cit.* The stability of emulsions previously quoted as WO in this system was much greater. Probably the sample of cresylic acid used had something to do with this, for the author has noted that in the system cresylic acid-gelatine-water, different samples of the acid caused different stabilities in the emulsions.[7]

18 : — (182 hr.). 15/5 : IVS⟶perfect chalky-pink OW (IT aq.). In 2 hr. this had creamed up, the cream being stable and OW by drop tests.** OW (P.s.S.) even after 4 days.

Emulsion 19 : (183 hr.). 5/15 : IVS⟶? Redder than 18. Clusters of curds which creamed down to a jelly-like "cream." This "cream" was tested in water, and it broke up into small oily patches (see emulsion 21, *J. Phys. Chem.*, paper by Woodman and Taylor[6]). Addition of large quantities of water with gentle shaking caused cracking.

Emulsion 20. (184 hr.). (The oil was uncoloured in this). 5/15 : IVS⟶a result similar to 19. The "undercream" portion was solid and jelly-looking. It was found possible by the aid of a spatula to pour off the supernatant liquid and to retain the "undercream", which mixed neither with water nor with oil.

Emulsion 21(*a*) :— (185 hr.). (Oil uncoloured.) 5/5 : IVS⟶perfect OW (IT aq. and oil).

21(*b*) : + 5 c.c. oil (ratio 5/10) IVS⟶stiff, smooth OW (IT aq. and oil) containing 66.7 per cent. of disperse oil. (The increase in viscosity in this "mayonnaise" experiment was added proof that the oil was the dispersed phase).

21 (*c*) : + 5 c.c. oil (ratio 5/15) : IVS⟶? Similar to 19 and 20. Much more mobile than 21(*b*). The clusters creamed down to a gel, which mixed neither with water nor oil. On drying this gel a residue resembling clay was obtained.

It was noteworthy that with emulsions 19, 20, and 21(*c*) no water was apparent even on keeping 48 hr., the liquid above the clusters being oil. The gel, therefore, seemed to be an entanglement (hydrated clay?) of clay and water. Most probably the systems were mixtures of clay and water suspended in the oil, *i.e.*, coarse dispersions of water and clay in oil, and therefore WO in that respect. This would explain the apparent breaking on addition of large quantities of water (see emulsion 21, previous paper,[6] and emulsion 19, this paper).

** Note the specificity of oils[6]; the corresponding hexalin emulsion 16 was unstable.

Emulsions 11-21 demonstrated that with very unstable emulsions it is apparently impossible—with the present methods of determination of types—to determine type definitely, the matter being one for the experimenter's personal judgment. Emulsions 20 and 21(*c*) proved that in some cases even the experimenter cannot safely form an opinion, for the apparent cream is immiscible with water and oil, the emulsifier evidently forming an entangled mass with one or both of the liquid phases.

Two further examples of this behaviour were noted in the systems hexalin (or methylhexalin)—Cook's Dried New Laid Farm Eggs (bought from Messrs. Sainsbury's, Cambridge)—water : at the ratio 5/15, IVS apparently gave perfect WO types as judged by immediate drop tests in water; these emulsions also apparently creamed down, no water being observed in the system on standing. The "creams" were found to be gels, immiscible with water and oil, and were thought to be some insoluble form of albumin plus water. These two and other systems are now being thoroughly investigated and the subject seems to be bound up with the relations existing between phenols and proteins.[7]

SUMMARY.

The methods of determination of type are reviewed, and it is shown that the surest drop tests are those carried out in water and in oil on the cream or apparent cream of an emulsion. The latter drop tests—like the electrical conductance and the usual dusting with indicator tests—can only be applied to a stable, or at least partially stable, emulsion. In all cases it is best to make other observations—detailed in the text—on the emulsions.

With very unstable emulsions the emulsion type — other than by immediate drop tests, which are apt to mislead—can only be guessed at by the experimenter concerned from the limited number of observations possible.

Examples are given where emulsifiers or portions of emulsifiers seem to combine or become mechanically admixed with the water phase, jelly-like insoluble substance resulting; drop tests in water carried out immediately after the formation of such emulsions are apt to be misleading. Further investigation of such systems is being made.

REFERENCES.

[1] Roberston, *Koll. Zeits.*, 1910, *7*, 7.
[2] Tartar, Duncan, Shea and Ferrier, *J. Phys. Chem.*, 1929, *33*, 435.
[3] Pickering, *J. C. S.*, 1907, *91*, 2001.
[4] Briggs, *J. Phys. Chem.*, 1914, *18*, 34.
[5] Clayton, *Brit. Ass. Colloid Repts.*, 1918, *2*, 114.
[6] Woodman, *J. Phys. Chem.*, 1926, *30*, 658; 1929, *33*, 88; *Chem. Age*, 1931, *25*, 146; *J. S. C. I.*, 1932, *51*, 95T; Woodman and Taylor, *ibid.*, 1929, *48*, 121T; *J. Phys. Chem.*, 1930, *34*, 299; *Chem. News*, 1931, *143*, 145; 161; Woodman and Gallagher, *J. Phys. Chem.*, 1929, *33*, 1097; Woodman and Wiley, *J. S. C. I.*, 1931, *50*, 187T.
[7] Woodman, unpublished data.
[8] Cooper et alia, *Biochem. J.*, 1912 *et seq.*; *J. Phys. Chem.*, 1926 *et seq.*

Horticultural Research Station,
School of Agriculture,
Cambridge University.

MODERN PYROMETERS.

DETAILS OF A NOTABLE POWER PLANT INSTALLATION.

By A WELL-KNOWN ENGINEER.

It is hardly necessary to emphasise that to-day power station practice is largely a matter of chemical engineering. This is well illustrated by the extensions now being carried out at the Millfields Road Power Station of the Borough of Hackney to operate at 400 lbs. per sq. in. pressure and 850° F. superheated steam temperature. Notable is an automatic heat control equipment on the entirely electrical system in which connection there is to be installed an equipment of " Foster " thermo-electric pyrometers, supplied by the Foster Instrument Company, of Letchworth, representing the latest scientific practice. Temperature measurements are given at 15 points for the turbine and 12 points in each boiler, and accessory equipment, that is, the superheater outlet, economiser water inlet and outlet, economiser gas inlet and outlet, air heater inlets and outlets, and the wind boxes of the stokers. Connection is made from all the 36 points on the three boilers to both an indicating and a recording instrument. The former, operating in conjunction with a multi-switchboard, is of the " edgewise " pattern with a translucent 10" scale, continually illuminated, and two temperature ranges, 0-600° F., and 0-1200° F. Beneath are a series of rotary switches by which connection is made immediately as desired to any of the 36 points.

The recorder is a 6-point instrument, giving by means of a multi-coloured ribbon, six continuous records on the same electrically-driven chart, each in a different colour, this ribbon lasting about 12 months, any of the 36 points on the 3 boilers are also connected to the recorder merely by screwing the six concentric connectors provided to the required points on the switchboard.

A number of refinements are also included in this equipment and, for example, both the indicator and recorder are magnetically shielded to the fullest extent, while a thermostatically controlled cold junction box is provided in the circuit which maintains at this point a constant temperature day and night, and the cables are compensated, thus eliminating all errors due to varying temperature of the cold junction. Also the cables, 15 in number from each boiler (allowing 3 spares) to the junction box, of which there is one for each boiler, and thence to the panel bus-bar board, are of the steel armoured multi-strand, copper-type and connect to the switchboard, having 45 plugs for the recorder, and to three 15-point double-pole rotary selector switches for the indicator, all the contacts on the studs, brushes, and collectors being of resistant rare metal.

The thermo-couples in the source of heat are of " concentric " construction, that is, the outer weldless tube used, capable of withstanding up to 1800 lbs. per sq. in. pressure, forms itself one of the dis-similar metals of the couple, the other metal being in the form of a wire welded inside. A number of advantages are represented by this type of thermo-couple, including a very rapid response to temperature changes since the thermo-couple is not " blanketed " by an outer sheath. From the heads of the pyrometer tubes connection is made to the junction box by means of steel armoured compensating cables, composed of the same alloy used for the tubes, but flexible, using also the " Foster " concentric connector in the head of the tube, while as usual the firm's " Resilia " patent mounting is included for the moving coils of the milli-volt meters, graduated to read temperature direct.

Hydrogen and its Uses

By E. F. ARMSTRONG, Ph.D., D.Sc., LL.D., F.R.S.

(*Continued from page* 213.)

The large scale uses of hydrogen.—The earliest technical use of the gas was for the inflation of balloons : subsequently it has found a number of minor applications in the arts. It is proposed only to deal with the major uses, namely :—

(*a*) The hydrogenation or hardening of fats.

(*b*) The hydrogenation of organic substances generally.

(*c*) The conversion of nitrogen to ammonia.

(*d*) The hydrogenation of mineral oil and coal.

Fat hardening dates in theory from the discovery by Sabatier, an Albert Medallist of the Royal Society of Arts, that the vapours of oleic acid when passed, together with hydrogen over heated, finely divided nickel catalyst, were converted into stearic acid, the so-called double bond between two carbon atoms—CH : CH—being reduced to —CH_2 : CH_2—. After some research W. Norman was able to apply the reduction process to liquid fats, which contain glycerides of unsaturated acids converting them into solid fats like tallow. With his aid the firm of Joseph Crosfield & Sons, of Warrington, developed the invention to a technical and commercial success in 1910. A rival, but similar process, was worked out by Lever Brothers. Latterly a much simpler process, which has the advantage of being continuous, has been perfected by Bolton and Lush.

In essence all processes depend on pure hydrogen, an active catalyst and oil as clean as possible. A nickel catalyst is very sensitive to poisons, such as sulphur and carbon monoxide, whilst its surface can be ruined by gummy matters in the oil. It is usual, therefore, to purify the hydrogen unless it has been made by electrolysis, and to give the oil a preliminary treatment to clean it. The preparation of the catalyst by reduction of nickel oxide deposited on a support demands special precautions. In the continuous process the catalyst used consists of nickel rods, shavings or turnings on which a surface film of oxide has been produced by anodic oxidation which is snbsequently reduced to active metal. It has an advantage in being less sensitive to poisons than a deposited catalyst. It is made up into cartridge-like cases in which it can be revivified repeatedly without any appreciable loss. In the batch process oil and catalyst are agitated at about 180° C., whilst hydrogen is passed through; in the continuous process the oil passes, together with hydrogen, through a series of tubes containing the catalyst. The two processeses have this difference, that in the batch method the oil is in contact with a minimum of catalyst so that a falling off in activity delays hydrogenation, whereas in the continuous process the oil is continually passing over fresh catalyst surface which may be said to be present in excess. An oil can be given any desired treament involving only a few degrees loss in iodine value or complete hydrogenation to a saturated fat, consequently a considerable range of industrial products can be made.

The commercial advantage of the process is based on the fact that at the time of its invention the difference between the market price of tallow on the one hand and whale and certain liquid oils on the other, was as much as £15 to £25 per ton, and there was every indication that the world demand for hard oils was likely to exceed the supply. The cost of hardening was estimated to be of the order of £3 per ton. As so often happens, economic changes of another kind upset these expectations. The whaling industry was able to increase its prices, that of tallow fell so that when the hardening costs had been added to whale oil, the profit margin became much less attractive. In the end the hardening industry has served to maintain a balance between the cost of hard and soft fats. One of the results of hardening in America has been a considerable increase per head stated as 10 lbs. in the consumption of vegetable oils : this has been commented upon as one of the most striking changes in food consumption that has taken place during the last 30 years.

The reverse change to the addition of hydrogen, namely, its elimination is termed dehydrogenation. It can be achieved in the laboratory though in practice the operation is neither so smooth nor so easy as that of

hydrogenation and consequently it has not so far become a technical operation. Were it feasible a way would be open to convert ordinary fats into the drying oils which are the raw materials of the paint and varnish and other industries, and form the basis or ground-work of the tough resistant protective film which it is the purpose of a paint to provide.

A pinch of active metal, a few per cent. of hydrogen gas, the chemist's magic wand and the animal and vegetable fats and oils of the world have been made more useful to man—no mean achievement.

The hydrogenation of other organic substances than the fats is being practised to an increasing extent on a technical scale, and there is every indication that as the practical uses of the products so formed increase, the method will become one of prime industrial importance in the great field of applied chemistry. It involves pure hydrogen, many catalysts and a knowledge of the same, a close control of the temperature and often increased pressure. The continuous form of apparatus described in connection with fat hardening has proved appropriate in many instances. The following table is a list of many substances hydrogenated and the product of the process : some of them cannot be prepared in quantity by any other method :—

Substance.	Product	Uses
Acetaldehyde	Ethyl alcohol	Solvents
Acetone	Isopropylalcohol	Solvents
Crotonaldehyde	Butylalcohol	Solvents
Phenol	Cyclohexanol (sextol) ...	
Phenol	Cyclohexanone (sextone) ...	Solvents
Cresol	Methylcyclohexanol	Solvents
Naphthalene	Tetralin...	Solvents
Pyridine	Piperidine	Absorbs CS_2
Nitrobenzene	Aniline...	Dyes
Indigo	Indigo white	Dyeing
CO	Methanol	Solvents and Formaldehyde
CO_2	Methanol	

Most of the products are used in the ever-growing solvent industry, which has given the world the new cellulose lacquer paints and varnishes, or in the artificial silk industry. Their use is extending daily and leading to novel and valuable products of every-day utility. Perhaps the most important on this list is synthetic methyl-alcohol or methanol, which thus becomes a product of water gas and can be produced at a far lower cost than formerly when it was obtained as one of the products of the destructive distillation of wood. Besides its important use as a methylating agent, methanol is the raw material for formaldehyde, a chemical of the widest utility, one of its prime services being the manufacture of synthetic indigo.

Allusion should perhaps also be made to the potentialities of hydrogenating phenol and its homologues. If the low temperature carbonisation industry succeeds a profitable outlet will be required for the additional quantity of phenols produced. It is possible to hydrogenate them cheaply and rapidly and with a minimum of purification by the continuous process so that the problem has rather become that of finding more extensive uses for cyclohexanol. These will no doubt be found, particularly when mass production makes it available at a lower price.

So much has been written about the conversion of nitrogen to ammonia that we can be very brief. The process is simple enough, a mixture of the gases nitrogen and hydrogen suitably purified is circulated over a catalyst at a temperature of 500° and a pressure of 100-200 atmospheres. The ammonia formed during each passage is scrubbed out. F. Haber established the equilibria of the reaction, Bosch and the Badische Company worked out the practical application. In later days Claude and Casale have introduced modifications working at higher pressures of 800-1,000 atmospheres : under such conditions more ammonia is formed and it liquefies on cooling.

The most up-to-date process is that of the Mont Ceuis Company.

For economic success most depends on the cost of hydrogen which has been steadily reduced as the result of experience. Three rival methods of making it have been tried. The electrolytic, when very cheap power is available, is not yet out of the race. The most favoured is the water gas process, but there are many believers in coke oven gas as the ideal raw material for hydrogen production. It is worth while discussing their relative merits if only as an example of the many factors to be considered in an economic question of this kind.

Water gas is made by blowing air and steam alternatively over coke in a producer, it consists of hydrogen, carbon monoxide and some carbon dioxide. Study has been given to the reactivity of the coke and to the economical amount of steam. In the second stage of the operation after purification of the gas from sulphur, the carbon monoxide is oxidised tto hydrogen and carbon dioxide by passing the gas mixed with more steam over an iron oxide catalyst: this is called the Bosch reaction. The resulting gas is compressed to 25 atmospheres and the carbon dioxide totally removed by scrubbing at first with water and finally with caustic soda. After compression to 200 atmospheres the small residual quantity of carbon monoxide is removed by washing with a solution of a cuprous salt and pure hydrogen, at a suitable pressure, remains.

It is more economic to mix water gas from the outset with such quantity of producer gas as will bring the hydrogen-nitrogen ratio of the mixture to the required figure of 3 : 1.

Coke-oven gas is a by-product of the ovens producing metallurgical coke for the steel works in this country, though both in America and Germany it is piped to the nearest gas works for use. When using it for ammonia synthesis all the constituents other than hydrogen and nitrogen are separated by the combined use of pressure and low temperature. The carbon dioxide is removed by washing at low pressure as above described. The gas is then fractionally cooled, whereby first the methane and then the carbon monoxide are removed.

The nitrogen-hydrogen mixture when adjusted to the proper proportions is ready for use; the fractions separated by liquefaction may be united to form a residual gas gets a credit for the full fuel value of it had in the original coke oven gas and can be used for heating. In other words, a plant making hydrogen from coke oven as gets a credit for the full fuel value of half the oven gas taken and has only to pay for half the gas and the cost of separation.

Taking each process under the most favourable large scale conditions, the cost of hydrogen by either of them is much the same being aboutu 1s. per thousand cubic feet. If an ammonia plant be located at or near a coke oven works, it is spared the capital cost of erecting producers. Against this saving must be set the fact that the hydrogen and hence the ammonia become by-products of the coke industry, and the site may not in other respects be favourable for ammonia production.

The ammonia is sold in the form of sulphate of ammonia prepared either by neutralisation with sulphuric acid, or double interaction with sulphate of lime (gypsum) and carbon dioxide, the other produet being a carbonate of lime suitable either for agriculture or for cement. The synthetic sulphate competes with that obtained in the gas works and latterly the price has been brought down so low by unreasoning competition that it costs more to recover the ammonia from the gas than can be obtained for it.

Synthetic ammonia plants have sprung up in every country—to-day their total capacity is estimated at 4 million tons per annum, whereas the total sales have only reached a figure of $1\frac{3}{4}$ million tons. Crookes gave his famous warning in 1898; within 20 years the chemist had solved the problem put to him, whilst to-day the price of nitrogen for the land has fallen to a figure of £7 per ton which would be within the reach of every farmer and horticulturist in a world a little less crazy in its economic structure than that which we live in at present. At all events there can be no fear of the world not being able to grow enough crops for lack of nitrogenous manures.

The production of sulphate of ammonia throughout the world in 1928-1930 is stated to amount to 2,138,500 million tons. If all this had been synthetic it would mean 97,500 tons of hydrogen and 455,000 tons of nitrogen had been used. Such a production of hydrogen would measure 41,000 million cubic feet. A like quantity of coal gas would nearly suffice to satisfy half of Greater London for a year, or three times the requirements of the City of Birming-

ham. It has been stated that the total capacity of all the synthetic ammonia plants in being may well be 4 million tons of sulphate per annum which involves a capacity to make some 70,000 million cubic feet of hydrogen, roughly equal in volume to one quarter of the total gas made in the British Isles. Such figures give some idea of the scale on which the ammonia industry is being worked.

The two uses of hydrogen we have already considered form more or less completed chapters: its use in conjunction with oil and coal is only on the threshold of industrial application. This is a subject of absorbing interest the world over; very large sums have been spent in experimenting and perfecting, nowhere as yet are plants in existence on a commercial basis. Though the problem has been solved technically it is still far from being economically attractive.

Thanks to the advent of the internal combustion engine this is an age of oil; on land or sea and in the air oil reigns supreme. There have been fears as to its possible exhaustion, as yet we have really used very little of it in total; at first it was wastefully produced. Oil displaces coal, therefore, the question arises can it not be produced from coal in greater quantity than the tar or oil is produced in a gas works. Bergius gave the first solution, coal made into a paste can be hydrogenated under pressure to oil and to-day a large yield of oil, mostly petrol, can be obtained from a suitable coal. The by-product is mainly methane from which hydrogen can be made when it interacts with steam in presence of a catalyst. The plant is an elaborate and costly one and so far the cost of producing petrol it put down at 7d. to 8d. a gallon which has to compete with a price of less than 2d. a gallon at the oil field. Such figures are only of passing import, the 7d. will be reduced, the 2d. may grow larger; what is important, is that petrol can be produced from coal at prices within practical bounds, so that oil could be produced from coal in this country when circumstances required.

The second half of the problem is the hydrogenation of tar. This, as produced from coal either at a gas works or by low temperature carbonisation, contains less hydrogen in proportion to carbon than does natural petroleum. Such oil ca be readily hydrogenated under increased pressure in presence of a number of catalysts yielding a commercial quality of petrol of high anti-knock value. Such low temperature oil can be hydrogenated more cheaply than coal and once it is available in really large quanties, a new home oil industry could be built up on it. It is only produced, however, together with a smokeless coke fuel in such proportions as 20 gallons of oil to 13 cwt. of the fuel: this fact makes the production of the oil, viewed from the commercial standpoint, essentially one of the production and sale of low temperature fuel. Until the coal factors and the public are educated to using such fuel the quantity of oil produced, even in countries which have no native supply, will lag behind the potential demand for it.

Many of the residues produced in refining oil are of low value; catalytic hydrogenation converts these into much more valuable products. Large experimental plants have been built in America to study this question on a commercial scale and have met with success and there is every reason to suppose that but for the present glut of natural oil they would have become part and parcel, along with the cracking and refining plants, of the oil industry. The price of petrol is, however, so low to-day that it will hardly permit of any treatment beyond topping the crude oil. The usefulness of hydrogen is understood to be so far confined to the production of what we may call special synthetic lubricating oils.

One of the good features of the hydrogenation process which in the future may have some bearing on its application, is the property hydrogen has of removing the noxious sulphur in the form of hydrogen sulphide gas.

Should the oil industry even take seriously to hydrogenation, it has a potential, cheap source of hydrogen available in the form of methane which readily interacts with steam forming hydrogen and carbon dioxide: either natural gas or waste refinery gas are at hand in large quantity at the very lowest cost, so that oil hydrogenation will have much cheaper hydrogen available than any ammonia plant.

A philosopher has said that we cannot deserve the future unless we honour the past. The story of hydrogen is one which involves the mention of many names, men who worked almost without apparatus and laboratory equipment in the modern sense,

and we can but marvel at how much was achieved.

Some of the men we have mentioned have had the capacity of transmitting what was common into what was rare.

The study of hydrogen has continually led to new discoveries, and it is certain that we have far from reached the end of all that there is to know about its atom and its molecule, its behaviour *per se* and in presence of catalysts or under conditions of high pressure or electrical excitement such as it will be exposed to in the laboratories of the future.

In its application to industry, to the service of man and his needs it has been described how hydrogen, won underground from coal, that is, from the remains of fossil plants laid down in past ages, can be used to build up some of the most urgent needs of man as well as to make substances which minister to his luxury.

Whilst Boyle must have viewed it as through a glass darkly, to Rutherford it must appear like a lighted chandelier of clearest crystal. In the days of the pneumatic trough but a few cubic centimetres were available, now the industrial chemist handles it in millions of cubic feet per day in quantities such that, owing to its extreme lightness, the largest gas holders only suffice for the storage of a few minutes' supply.

It has been shown, with hydrogen as an illustration, how the complexity of things has become more clear, how indeed the excitement of living has become more urgent. Truly it may be said "the man of genius sees things charged with energy, or brilliant with colour or breathing with perfume."

Such is the story of hydrogen.

AUSTRALIAN LARGE COAL TAR INDUSTRY.

There are a number of gas companies and one large producer of by-product coke, which supply most of the Australian requirements for coal tar and coal-tar by-products. The total coal-tar output of these plants amounted in 1929 to 23,596,940 imperial gallons. Other products manufactured are road tars, coal-tar pitch, ammonium sulphate, pyridine. There are also a number of tar distillers placing on the market products such as coal-tar disinfectants, coal-tar base paint, tar acid oils and coal-tar cleaners.

PROF. JULIAN HUXLEY'S VIEWS ON SOVIET RUSSIA.

A party of distinguished British scientists recently visited Soviet Russia and spent a month in seeing the academic and technical Institutes of Leningrad and Moscow and meeting some of Russia's leading men of science. An account of these and the general position of science under the Soviet was given in Mr. Crowther's *Science in Soviet Russia* (Williams and Norgate, 7s. 6d.). On March 21st Prof. Huxley described his vivid impressions in a lecture to a scientific audience at King's College, London. He declared that it was the most remarkable in the whole of his travels, no obstacle was placed in his way when he asked to see over any institute or to find out what was being done in connection with pure and applied science, medicine, public health, education, factory and agricultural practices, etc. He found that the people were not undernourished, even though population was increasing to the extent of three millions annually. Indeed, health received special attention. There were, however, certain commodities, *e.g.*, leather goods, which were scarce and others that were very dear, especially in the private markets, which still did some business. The Russian authorities had organised science very efficiently and were quick to apply discoveries and inventions to daily life and industry. All results were tried out on an extensive scale and if successful were adopted at once. Everyone was encouraged to make suggestions for improvements or new devices and all suggestions were carefully considered. Those considered as feasible were developed by their sponsor, who was sent to a research station under the control of one or other of the government ministries. If the inventor happened to be a worker he was allowed facilities in which to perfect his invention.

Perhaps the most remarkable achievement of the Soviets was in education. Many new schools had been erected, often in the vicinity of factories and they were usually given a vocational bias and scholars were encouraged to qualify for higher education. It was manifest to an impartial observer that the Five-Year Plan would ultimately succeed, even if it took longer than was originally expected. Russia was in reality a vast empire with enormous potentialities.

Review of World Chemicals

GERMAN SODA PRICES REDUCED.

The German soda syndicate reduced its sales prices, effective as of January 1, for soda ash in the domestic market from 11.10 to 9.95 Reichsmarks per 100 kilos, free consumer's station. This reduction of 10 per cent. as a consequence of the emergency decree, is the first time since May 1, 1931. The caustic soda syndicate similarly reduced its sales price of caustic soda in the same proportion from 25.00 to 22.50 Reichsmarks per 100 kilos. The sales price of crystal soda was lowered by the large producers, who were followed by the small producers, from 8.25 to 7.42 Reichsmarks per 100 kilos corresponding to the price reduction for calcined soda.

GERMAN ALCOHOL OUTPUT AND SALES DECLINE.

German production of 2,562,286 hectolitres of alcohol in the fiscal year ending September 30, 1931, was considerably below the 1929-30 level of 2,881,612 hectolitres. Alcohol stocks in the hands of the Monopoly continued to increase, amounting in October 1, 1930, and 1931, to 1,578,010 hectolitres and 2,008,904 hectolitres respectively. The sale of alcohol for motor fuel mixtures doubled in 1930-31 to 508,136 hectolitres compared to 235,135 hectolitres in 1929-30. Sales for other uses and total sales declined markedly over the preceding year.

SODA ASH PRODUCTION IN JAPAN INCREASED.

During 1931 both the Asahi Glass Manufacturing Company and the Dainihon Kali K. K. increased production of soda ash so that the total for that year was 80,000 metric tons compared with 60,000 tons in 1930. It is now reported that the Asahi Glass Manufacturing Company will produce some 60,000 tons during the current year and the Dainihon Kali K. K. will produce an equal amount making a total of 120,000 tons. The 1931 import figures for soda ash are not available. In 1930, there was a decline to 72,000 tons from 87,200 tons in 1929.

I.G. REPORT FOR LAST QUARTER, 1931.

The quarterly business report of the German Dye Trust for the last quarter of 1931 indicates unsatisfactory export trade and a further decline. The situation in the various branches of the Dye Trust remained unchanged since the last report in November, 1931, except that regarding the currency of numerous countries.

FRENCH POTASH PRODUCTION IN 1931 DROPS.

Preliminary reports indicate a sharp contraction in the production of potash by the domanial mines in Alsace. Crude salts extracted totalled 1,500,000 metric tons in 1931, as compared with 2,133,000 tons in 1930, a decline of 30 per cent. Kali Sainte Therese, the private producer, reported extraction of 1,002,000 tons in 1930.

NAPTHTALENE IMPORTS INTO CUBA FALL SHARPLY.

Cuban imports of naphthalene dropped radically in 1931 to 248 kilos from 16,307 kilos in 1930. All of the 1931 shipments came from the United States while Belgium supplied 10,908 kilos of the 1930 imports.

COMPRESSOR FOR HYDROGEN—CANADA.

H.M. Trade Commissioner at Toronto reports that a local concern are desirous of purchasing in the United Kingdom a compressor capable of compressing hydrogen to a pressure of 2,000 lbs. per square inch in steel bottles or tanks. They require a machine to handle 20 cubic feet of free hydrogen per minute.

CARNAUBA WAX, BRAZILIAN OUTPUT LARGE.

It is estimated that the Brazilian output of carnauba wax during 1931 was above the average in quantity and quality and that exports exceeded 3,000 tons.

WORLD EXPORT TRADE IN PHOSPHATE ROCK.

A diminished superphosphate consumption in Europe during 1931 and a heavy carry-over of supplies of rock from peak shipments during 1930 caused an important decline in the 1931 movement of rock from producing countries to European ports. Preliminary statistics of exports from the United States, Tunisia, Morocco, and Algeria would indicate that the Tunisian and Moroccan sales were each off about 900,000 tons.

	1930 Metric tons	1931 Metric tons
Algeria	765,000	459,000
Morroco	1,779,000	901,000
Tunisia	2,643,000*	1,725,000
United States ...	1,285,000	967,000

* Estimate for year based on actual exports of 1,628,772 tons during first 11 months.

CASTOR SEED UNDER GREATER CULTIVATION IN INDIA.

India is an important source of castor seed for castor oil production and indications point to an extension of the activity in India. From the Madras Presidency, which usually acounts for about 20 per cent. of the country's castor seed acreage, comes the report that about 324,300 acres are under cultivation as compared with 256,000 acres in the fiscal year 1929-1930.

THE SOYA BEAN INDUSTRY IN JAPAN.

The South Manchurian Railway, under Japanese control, is looking for capital to assist it in exploiting the Manchurian soya bean industry, according to reports received from the Consulate General at Mukden.

Oil will be extracted from the beans, according to tentative plans of the railway company, by the use of alcohol instead of benzine, and the cake produced in the course of extraction will be used for making yeast and feed for poultry. The company is said to have a patent on the new method of extraction.

During January, shipments of beans from Vladivostok and Dairen, totalled 174,000 metric tons, as compared with 233,000 metric tons sent out during the same period last year.

CANE SUGAR AS AN INDUSTRIAL RAW MATERIAL.

Intensive study is now being made of cane sugar as an industrial raw material. Drs. Gerald J. Cox and John Metschl, of Mellon Institute of Industrial Research, Pittsburg, Pa., have reported the progress of some of their investigations at the meeting of the American Chemical Society at New Orleans on March 29th, 1932.

One of the substances that they have made from sugar, sucrose octa-acetate, has been found valuable in certain types of lacquers and adhesives and in the fabrication of paper. A similar product, sucrose benzoate, has applications in the same fields.

By treatment of sugar with acid at high temperatures, a substance called levulinic acid is produced; and, when it in turn is combined with certain alcohols, fragrant esters are formed that have useful solvent powers.

But of greatest interest is their investigation of the practice of mixing sugar in lime-sand mortar. Controlled tests have shown that, if as little sugar as 6 per cent. of the quicklime is included in mortar, the tensile strength is increased about 60 per cent. With the present low price of sugar, the addition of 5 or 6 pounds of sugar for each 100 pounds of lime adds very little to the cost of laying bricks or plastering walls. The sugar is added dissolved in water after the lime has been slaked.

VENEZUELAN MARKET FOR INSECTICIDES BETTER.

There is a growing demand in Venezuela for insecticides and disinfectants of various kinds, especially sprays for animals. At present quite a variety of products are on sale, including manufactures of the United States, Germany, and Argentina. The most popular brands of animal and insect sprays are the products of the large oil companies, and new products should expect to meet keen competition. The demand for wood preservatives for interior use is comparatively limited as furniture is usually made of woods that are not attacked by insects. For marine preservatives the demand is small since few vessels owned here ply the waters along the coast. Harbour works and similar constructions are few and chiefly of cement.

DECLINE OF GERMAN FERTILISER SALES.

According to a recent official census, the decline in the sales of fertilisers in Germany during the first six months of the fertiliser year, 1931-32, is estimated at 50 per cent. for nitrogen, 20 per cent. each for superphosphate and basic phosphate slag and as high as 63 per cent. for fertiliser lime. The decline in the total sales of potash salts, in both the domestic and foreign markets, was 28 per cent. in the calendar year 1931.

CUBAN IMPORTS OF TURPENTINE IN 1931.

Receipts of turpentine into Cuba during the year declined sharply, and the quantity decrease amounted to about 50 per cent. as compared with 1930. The decrease in imports may be attributed chiefly to conditions existing in the domestic paint industry. Total imports for 1931 were 145,464 kilos of which 109,902 kilos came from the United States, 32,000 kilos from Mexico, and the rest from Germany. These figures compare with the total importations of 303,791 kilos during 1930, the United States shipping 234,006 kilos, Mexico 52,888 kilos and Germany 158 kilos.

SCIENTIFIC AGRICULTURAL PROGRESS IN RUSSIA.

From our Russian Scientific Correspondent.

According to the Russian agricultural daily paper, *Socialistichaskaya Zemledelia,* the sowing of seeds by aeroplane is twenty times as fast as sowing by ordinary farm tractor sower.

Over 1,500 acres have been sown by aeroplane at the collectivist farm "Udarnick," in Central Asia (Greater Russia) and the results are stated to be beyond all expectations.

It is claimed that the ordinary "caterpillar" type of tractor sower takes 30 working hours to cover from 90 to 100 acres whereas an aeroplane can drop seeds over 120 acres in two hours.

Naturally, great care has to be taken by the pilot to ensure regular distribution, just under one cwt. per acre, and for complete success, it is stated the plane should be flown at no greater height than 50 feet.

Proceedings and Notices of Societies

THE CHEMICAL SOCIETY OF JAPAN.

Papers communicated :—

Velocity of Permeation of Electrolytes through a Membrane. VI. Permeation of Two Kinds of Electrolytes with a Common Ion. II. By Shinnosuke Matuura.

A Simplified Micro-Combustion Method for the Determination of Carbon and Hydrogen. By Miss Chika Kuroda and Miss Mizu Wada.

On the Chemical Constitution of Mangostin. III and IV. By Masuo Murakami.

A Study on the System of Cadmium Bromide and Ethyl Alcohol. By Fusao Ishikawa, Ichiro Mori and Toyosaku Murooka.

Experimental Studies on the Sugar Decomposition by Bacilli. VI. Qualitative Observations on Gas Production. By Keiichi Shikata.

Amino Acids and their Derivatives. IV. Synthesis of Glyoxaline Derivatives from α-Amino Acids. II. Synthesis of Some New Glyoxaline Derivatives. By Shiro Akabori and Shinji Numano.

Amino Acids and their Derivatives. V. Synthesis of Some New Glyoxaline Derivatives from α-Amino Acids. III. Synthesis of Two Higher Homologues of Histamine. By Shiro Akabori and Takeo Kaneko.

Amino Acids and Their Derivatives. VI. Synthesis of Glyoxaline Derivatives from α-Amino Acids. IV. A New Synthesis of Histamine. By Shiro Akabori and Shinji Numano.

ROYAL INSTITUTION.

At a general meeting of the Members of the Royal Institution held on April 4th, Sir Robert Robertson, Treasurer and Vice-President, in the chair, Mr. J. Y. Fletcher, Dr. F. H. Garner, Miss Caroline H. Haslett, Mr. G. T. Hoyes, Mr. Hugh Macnabb, Mr. A. W. C. Mellor, Mr. George Riddoch and Mr. G. A. Sawyer were elected Members.

Notices of Books.

Potter's Cyclopaedia of Botanical Drugs and Preparations. By R. C. Wren, F.L.S. Fourth Edition revised by Henry Potter, Ph.C., F.L.S., and Richard W. Wren, M.P.S. 7ins. x 4¾ins. Pp. xliv + 406 + 12 plates. London: Messrs. Potter & Clarke, Ltd. 60, 62 and 64, Artillery Lane, E. Price 5s. net.

A fourth edition of this well-known and extremely useful book is very welcome. Of special interest to pharmaceutical chemists, it is a handy and concise work of reference that should be found in the library of every chemist interested in medicinal plants; and, it should be added that the utility of these plants is not limited to medicine; many are employed in the manufacture of perfumery raw materials, flavouring essences and various beverages (liqueurs, bitters, etc.), so that the appeal of the book is really wider than might, at first, be imagined.

It contains details concerning about 600 botanical drugs, the information given comprising the common and scientific names of the plants from which they are derived, parts used, medicinal action, preparations used in medicine, distinctive characters, etc. Under medicinal preparations, the references to the B.P. should have been dated, as some are no longer official, and the date 1898 in the statement that santonin "is official in the B.P. 1898" should be altered to 1914, as otherwise the impression is conveyed that santonin is not now official.

Apart from these two minor points of criticism, we have nothing but praise for the book, which is a marvel of conciseness, very clearly printed, and extremely cheap. It contains a number of useful appendices, and an admirable Index, and is enriched with numerous drawings of British medicinal plants by W. H. Fitch, F.L.S., and W. G. Smith, F.L.S., and twelve beautiful plates (not included in previous editions) of medicinal plants photographed in colour direct from Nature.

H. S. R.

An Index to Acts of Parliament and Statutory Rules and Orders Affecting the Chemical Industry. Published for the Association of British Chemical Manufacturers by W. Heffer and Sons, Ltd., 1931. Pp. 24. Price 2s. Supplement No. 1,1932, Price 6d.

The modest size of these publications is no indication of their importance. Their contents are of vital interest to all concerned in chemical works' administration whether from the director's chair or from the laboratory, and to all interested in the supervision of industry by Government. The object has been to supply the definite of members of the A.B.C.M. for a list of Acts and Orders particularly affecting the chemical and allied industries, and at the same time to avoid the trouble of consulting the voluminous Government Indexes, which of course aim at completeness and therefore include many irrelevant items. It should of course, be understood that only the title of the Act or Order is given, the number, date and administrating authority however, being also included.

The items are given alphabetically by subjects with any necessary cross-references, and are printed on one side of the paper only in order to enable them to be cut up when desired and pasted on cards so as to provide a card index. The subjects vary widely in scope, *viz.*, Partnership, Chrome Ulceration, Trade Catalogues, Trade Disputes, First Aid Exhibitions, Drains and Sewers, and Trucks may be cited among those of more general interest. The largest number of items (19) comes under the heading of Dangerous Drugs, but 15 enactments refer to Spirits, and 17 to the Factory and Workshop Acts (including Welfare). For some of the more important headings complete lists of the Orders in Force at certain dates are available, and these are indicated.

A supplementary issue for 1931, which may also be cut up and included in the card-index, serves to bring the list up-to-date. It comprises 23 headings referring mainly, though not exclusively, to 1931 Statutory Rules and Orders, and including the Abnormal Importations Act, Customs and Excise Publications, Diseases of Animals, Dangerous Drugs, Petroleum, Safeguarding of Industries, and Workmen's Compensation Acts.

These publications deserve wide publicity and their compilers, Messrs. J. Davidson Pratt and Allan J. Holden, are to be congratulated.

Incidentally, mention may also be made of two useful monograms issued by the same organisation which enable the interconversion of English and Metric weights

and measures to be performed in a few seconds. They are printed on fairly stiff cardboard and are excellent value for the few pence for which they can be bought (obtainable from the A.B.C.M., 166, Piccadilly, W.1.). The writer has had frequent occasion to put them to the test, and can testify to their usefulness and accuracy.

J. G.

Chemical Manufacturers' Directory. 1932. Pp. 205. London : Simpkin Marshall Ltd. Price 4s. 6d.

The sixty-fourth edition of the *Chemical Manufacturers' Directory* of England and Wales, with some of the firms in Ireland, has just been published. It contains the names of practically all the chemical manufacturers of the above countries, and should therefore prove very useful to all those connected with chemistry and the chemical trade. A classified list of chemicals showing the makers of each kind together with a list of chemical brokers, and chemical manufacturing agents in London are also given.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by permission of the Controller of H.M. Stationery Office and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., price 1/- weekly (annual subscription, £2 10s.).

Latest Patent Applications.

8,266.—Kroll, W., and Siemens and Halske Akt.-Ges.—Treating iron-nickel-beryllium alloys. March 19th.

Specifications Published.

368,782.—Johnson, J. Y. (I. G. Farbenindustrie Akt.-Ges).—Purification of acetylene.

369,120.—Norddeutsche Affinerie. — Recovery of nickel and cobalt or pure salts thereof.

369,141.—Skarblom, K. E.—Manufacture of ethylene glycol.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

364,049.—Zinc chloride.—White, A. E., 5, Quality Court, Chancery Lane, London— (American Smelting and Refining Co., 120, Broadway, New York, U.S.A.).

Zinc chloride is freed from lead, lead chloride, or lead oxychloride by melting it in the presence of excess of zinc and continuously circulating portions of the molten salt through an underlying bath comprising metallic lead until the lead &c. has been extracted. The slag of pure zinc chloride is then removed from the surface of the bath. The operation may be carried out at 730-760° F. The zinc chloride may be that obtained from lead containing zinc as an impurity and obtained for instance in desilverising lead by the Parke's process, the dezincing step being effected by heating the lead to 650-750° F. and continuously circulating portions of the molten lead through a chlorinating chamber until the zinc chloride slag floating on the molten metal becomes contaminated with lead chloride. From the zinc chloride obtained zinc and chlorine may be recovered for further use in the process.

Group Abridgments can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., either sheet by sheet as issued on payment of a subscription of 5s. per Group Volume or in bound volumes, price 2s. each.

The Latest Trade Marks

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of His Majesty's Stationery Office.

RADCAPS.

529,534.—All goods in Class 1 which includes chemical substances used for manufactures, photography, or philosophical research and anticorrosives. — Harold Douglas Mackie, trading as Triangle Manufacturing Company, 134, Deansgate, Manchester. March 23.

SHAVON.

529,781.—Anti-corrosives.—Norman Fergus Duncan, 1, Mornington Street, Belfast, Northern Ireland. March 23.

THE CHEMICAL NEWS

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A WORLD SURVEY OF RECENT OIL SHALE DEVELOPMENTS

By A. A. SWINNERTON*

In many parts of the world there are very large deposits of what are known as oil shales. These deposits consist essentially of mineral matter of a clayey or slatey nature, containing widely varying quantities of organic matter, which, when heated, undergoes decomposition with the production of crude oil and ammonia. Many attempts have been, and are being made, to obtain oil from oil shales in commercial quantities and it is the more recent of these developments that are the subject of this paper. Generally speaking, the greatest activity has taken place in those countries which must depend on imported petroleum for their requirements, and has been prompted by the desire to render themselves less dependent on foreign supplies of this important commodity.

WORLD PRODUCTION: The accompanying table[1] has been compiled to show the production of oil shale since 1919 in the various countries that are exploiting or attempting to develop their oil shale resources. With the exception of Scotland and Esthonia, and possibly Manchuria in the near future, the production is still quite small, but more countries are commercially interested in oil shale than is generally realized. It will be noted that in 1919 the Scotch production was about 95 per cent. of the total, but less than 80 per cent. by 1928-9. During the same period the Esthonian production had risen from almost nothing to nearly 18 per cent., the remaining 2 to 3 per cent. being mainly from France and Spain. The recent developments in the different countries are reviewed hereunder.

[1] *Mineral Resources of the United States, U.S. Geol. Sur.* (Annual Reports).
Annual Reports of the Secy. for Mines, Mines Dept. (Great Britain).

* Chemical Engineer, Fuel Research Laboratories, Division of Fuels and Fuel Testing. Mines Branch, Department of Mines, Ottawa, Canada.

BRITISH EMPIRE.

CANADA. During the last 2 or 3 years there has been a renewal of interest in the oil shales of the Maritime Provinces, three companies having erected experimental plants—one in New Brunswick and two in Nova Scotia—for treating these shales.

In New Brunswick the Maritime Education Company, which was organized to develop the deposits near Rosevale in Albert county, completed the erection of their plant in 1928, but owing to various legal and financial difficulties, never got into production. The layout consists of crushers, retort house with a lead-jacketed cylindrical retort, Cottrell precipitators, condensers, storage tanks, and a small "Wade" hydrogenation or cracking unit. In addition there is a boiler and power house, machine, carpenter and blacksmith shops, as well as living accommodation for about 50 men. Financial reorganization has taken place and it is hoped to obtain the capital necessary for starting operations in the near future.

In Nova Scotia, the Torbanite Products, Limited, completed the erection of their plant in 1930, the first run being made in July of that year. This plant is on the outskirts of New Glasgow, close to an exposure of oil shale into which a tunnel has been driven, and comprises crushing and hoisting equipment, Ginet retort, condensers and storage tanks, as well as pulverizers and bagging equipment for the spent shale, for which the company claims to have a ready market. The Company, however, had a bad fire, resulting in the loss of most of their buildings, soon after they started operations, and at the present time it would appear that future plans are still indefinite.

At McLellan Brook, about five miles from New Glasgow, The Canadian Torbanite and Oil Products, Limited, erected a small experimental unit in 1929, which operated for two or three months. The equipment consists of laboratory building, retort house with two small internal combustion retorts, condensers and storage drums. Most of the work in 1930 consisted of refining studies of the crude oil produced in 1929, and according to a press report British interests contemplated the erection of a 1,000-ton a day plant here during 1931[1].

ENGLAND. In England[2], the only recent development reported was the unsuccessful attempt in 1919-20 of the English Oil Fields, Limited, to exploit the large shale deposits of Norfolk. A large plant was erected and a certain amount of oil was produced, but the company went into liquidation after operating for a short time.

SCOTLAND. In Scotland[3], the distillation of shale started about 1850, and was carried on with great success till after the Great War when rising costs and falling prices caused a curtailment of operations. As a result of an amalgamation with the Anglo-Persian Oil Company, under the name of Scottish Oils, Limited, distillation of shale is still carried on in conjunction with the refining of imported crude. The refineries at Grangemouth and Uphall, with capacities of 2,000 and 3,000 barrels a day respectively, refine imported Persian crude and refineries at Pumpherston and Oakbank with a total capacity of approximately one million barrels a year handle shale oil exclusively. The position of the Scottish shale industry has improved greatly since the spring of 1928 when a duty of fourpence per gallon was imposed on imported gasoline. Cracking units have been installed in order to increase the gasoline output at the expense of the heavier oils, the first one starting operations in 1930, but the decrease in the value of the other products, namely, ammonium sulphate and paraffin wax, has largely nullified the good effect of high gasoline yield. According to a recent press report the British Cabinet were considering an "oil quota" plan for aiding the Scottish shale industry, whereby consumers would be compelled to use a certain proportion of home-produced gasoline. The present hopes for the Scottish shale industry are based on the vigour which is being displayed in devising new methods to meet changing conditions.

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1 *Engineering Institute of Canada News*, Jan. 15, 1931.

2 *Pet. Times*, London, Vol. 4, p. 261 (1920), Vol. 4, p. 239.
Oil Paint & Drug Reporter, Vol. 99, No. 5, p. 18 (1921).

3 *Pet. Times*, London, May 1930, p. 794; March 14, 1931, etc., Jan. 24, 1931.
U.S. Commerce Report, Dept. of Commerce, April 6, 1931.

AUSTRALIA. In Australia[1] no permanent industry has as yet been established in spite of the fact that the rich oil shales of New South Wales were worked as long ago as 1865. In 1908 the Commonwealth Oil Corporation began the construction of a plant at Newnes, consisting of a bench of 64 Pumpherston retorts, which operated from 1911 to 1912. In 1914 this company was reorganized as John Fell and Company. New retorts were installed and with the assistance of a shale oil bounty the company continued operations till 1923-24 when it became unprofitable due to high labour costs and low prices of crude oil. It is reported that the Broken Hill Syndicate and associated companies have an option on the plant at Newnes and are organizing a company to resume operations. It is also reported that successful tests have been conducted at Epping, New South Wales, of a new type of retort, and that a company is being organized to erect four of these retorts at Newnes, which, it is expected, will produce 10,000 gallons of crude oil per day. The grant of £100,000 that the Australian Government has set aside to assist in restoring the shale industry lends additional interest to these reports.

In Tasmania[2], the Director of Mines reports considerable activity. The Tasmanite Shale Oil Company, the Australian Shale Oil Company, and the Goliath Cement Company at Railton are all engaged in experimental work.

NEW ZEALAND. In New Zealand[3], a syndicate has been formed to try and reopen the Orepuki oil shale works that were in operation about 25 years ago, and which closed down owing to removal of the bounty on shale oil.

SOUTH AFRICA[4]. In South Africa torbanites and oil shale appear to be widely distributed. The Vergelegen Shale Oil and Mineral Company is reported to be planning large scale exploitation in Natal and it is reported that a plant has been ordered from Scotland. The Transvaal Oil and Petrol Industries, Limited, has been formed in Pretoria to develop the torbanites of the Ermelo district and according to reports a pilot plant has been in operation from which crude oil has been obtained at a cost of 5 cents a gallon (including mining costs).

EUROPE.

ESTHONIA. Great interest has been taken in the shale deposits of Esthonia[5] during the last few years, and the annual production now amounts to more than half a million tons. The state operates one mine and six others are operated by private companies, the greater part of the output being used directly as a fuel for locomotives, power plants, cement factories, etc., only about 10 per cent. being retorted for the production of oil. There are at least 3 distillation plants in operation; (1) The state plant at Kohtla which uses Pintsh retorts; (2) The Esthonian Oil Shale Company plant near Pussi, where the shale is distilled in perforated waggons which pass through an internally heated tunnel; and (3) The New Consolidated Goldfields of London, Ltd., who are reported to have had 6 Davidson rotary retorts in operation at Kohtla since June 1931, refined gasoline and other products being made from the crude oil. It is reported that the government gasoline cracking plant will soon be in operation and will produce 4,000 tons of gasoline a year, and that another 5,000 tons a year will be produced at the plant at Pussi. As the domestic requirements amount to less than 7,000 tons a year, a surplus will be available for export.

FRANCE. In France[6], shale has been dis-

[1] *Oil Shale*, Bull. 21, U.S. Geol. Sur., M. J. Gavin
Pet. World, Oct. 1927, p. 390; June 1928; Oct. 1928.
Pet Times, Jan. 17, 1931; May 16, 1931.
Engineering, March 20, 1931, p. 385.

[2] *Chemistry and Industry*, Sept. 27, 1929, p. 940.
Pet. World, June 1928, p. 226.
Pet. Times, Feb. 12, 1927.
Min. Resources No. 8, Dept. of Mines, Tasmania.

[3] *Pet. Times*, Aug. 16, 1930.

[4] *Jour. Inst. Pet. Technologists*, Oct. 1930.
Pet. Times, Dec. 27, 1930, p. 1043.
Pet. Times, July 25, 1931.
Mining & Industrial Magazine of South Africa, July 8, 1931, p. 367.

[5] *Colliery Engineering*, Oct. 1930.
Pet. Times, July 19, 1930, July 18, 1931, Oct. 31, 1931.

[6] *Industrial Chemist*, 1926, pp. 391 and 445.
Chemie & Industrie, Special No. May, 1923, pp. 398-410.
Pet. Times, May 16, 1931, p. 718.

tilled since 1845—the principal deposits being at Autun (Saone and Loire) and Bruxiere-les-Mines (Allier), both of which have been worked continuously from about 1860 till after the Great War. At present only the plant at Autun is in operation. In 1930 this plant retorted 76,000 tons of shale, with the production of about 40,000 barrels of oil. It is reported that an attempt is now being made to have the French Government provide assistance in re-starting operations at the Allier deposits.

ITALY. In Italy[1], deposits of oil shale have been known for some time but very little information is available regarding them. With the assistance of a government contract and a small bounty on production, steps are now being taken towards the erection of a plant at Rugasa in Sicily, capable of producing 50,000 tons of crude oil from the Sicilian deposits of asphaltic rock.

SOVIET RUSSIA. In Soviet Russia[2], oil shales are widely distributed, the deposits near Leningrad and in southern Russia being the best known. The shales near Leningrad are used as raw materials for gas manufacture and also directly as a fuel, but information is very meagre regarding any developments in other parts of the Soviet Russia Republic. Near Shegloosk, Siberia, an experimental retorting plant has been erected to treat the local shales. This is reported to be the first shale plant to be built in Siberia.

SPAIN. In Spain[3], a plant has been in operation for the last ten years at Puertal-lano near Madrid, which produces about 3,500 gallons of oil per day from which gasoline, kerosene and the usual refined products are obtained.

SWEDEN. Sweden[4], has abundant deposits of bituminous shales which due to its richness in potash and alumina have been used from the seventeenth to the end of the nineteenth century as raw material for the preparation of alum. For the last 50 years the bituminous content of these shales has attracted a certain amount of attention as potential raw material for the production of oil and during the last few years a number of small experimental plants for the recovery of the oil have been erected. At the present time, according to press reports, there is a 50-ton per day plant at Kinnekull which can produce oil at a lower cost than that of imported oil. This plant is situated in south-western Sweden on the shores of lake Vanerin, and it is reported that the Swedish Government contemplates taking over its operation as the Government Committee appointed to investigate the Swedish shale oil industry recommended that the Government purchase the plant as its maintenance is considered of vital importance to the Swedish navy.

ASIA.

MANCHURIA. The oil shale deposits at Fushun[5], near Mukden have aroused great interest in Japan, where the desire to find a native source of oil is very keen. Owing to the fact that they overlie a large open-cut coal mine which is being worked by the Southern Manchurian Railway, mining costs are considerably reduced. Although they are of very low grade, yielding only about 13 gallons per ton, such large quantities have to be removed that the Japanese Government have decided to retort them for their oil content. A plant has been erected consisting of eighty 50-ton retorts in two sections, each section containing a double row of 20 retorts, side by side, the distillation being effected by a combination of low temperature carbonization and total gasification. It is estimated that this plant will produce 69,000 tons of crude oil and 18,000 tons of ammonium sulphate annually. The oil is exported to Japan and refined there, a large amount being required for the Japanese navy and the ammonium sulphate can be disposed of either in Japan or southern China. Although

[1] *Pet. World*, May 1931, p. 152.
[2] *Shale Oil*, R. H. McKee (Chem. Cat. Co., N.Y.). *Pet. World*, Aug. 1931, p. 263.
[3] *Eng. & Min. Jour. Press*, Vol. 115 (1923). pp. 326-7.
[4] *Pet. World*, Dec. 1929, p. 459. *Pet. Times*, March 1, 1930. *Pet. Times*, May 23, 1931, p. 741.
[5] *Fuel in Science and Practice*, March 1929, p. 133. *Pet. World*, Feb. 1930, p. 58. *Pet Times*, Oct. 1, 1927. *Pet. Times*, Sept. 13, 1930.

starting early in 1930, the plant was not in full operation till near the end of the year, consequently figures regarding output and costs are not yet available, but if they prove satisfactory, the plant will in all probability be considerably extended, as it can handle only about a quarter of the shale that is removed in mining the annual coal output of 3 million tons.

UNITED STATES.

In the United States, where much interest was aroused in oil shale developments just after the war, the most important recent development has been the operation of the Bureau of Mines experimental oil shale plant, which includes both the retorting equipment near Rulison, Colorado, and the small-scale refinery and research laboratories at the University of Colorado at Boulder, Colorado. The plant at Rulison was in operation from September, 1926, to July, 1927, and from May, 1928, to June, 1929, during which time about 5,000 tons of shale were retorted with the production of about 100,000 gallons of crude oil. The retorting plant at Rulison includes two retorts (a Pumpherston and one of American design known as the N-T-U) boiler house gas producer, turbogenerator set, machine shops, etc., office and laboratory building as well as a certain amount of living accommodation. The shale for the retorts was obtained from an escarpment about one mile distant and 2,800 feet above the plant site, and transported to the retorts by aerial tramway. The Pumpherston retort is well known and does not require description here, but the N-T-U is a comparatively new design, the main feature of which is distillation by direct combustion of part of the charge, regulated by admission of air and return gases. The work done at the plant at Rulison has demonstrated that shale oil can be produced with reasonable satisfaction from American shales by retorts of types available for large scale operation. As a result of the work done at the refinery and laboratory at Boulder, methods have been found for refining shale oil and obtaining a gasoline with low sulphur content and good anti-knock properties without undue refining losses. A very full description of the work carried on by the United States Bureau of Mines at their experimental plant in Colorado is given by M. J. Gavin in Bulletin 315 of the Bureau of Mines.

In north-western Colorado, there may be seen the remains of a large number of oil shale plants which either through poor design or insufficient capital never went beyond the experimental stage, a typical one being the plant of the Washington Shale Oil Company on Conn Creek near Debeque. This company used an inclined retort in which the shale was distilled by cascading over heated baffles, the oil vapours leaving by means of off-takes provided at the side of the retort.

The only other large scale developments which took place in the United States were in Nevada and California. In Nevada[1], Mr. Catlin built a plant near the town of Elke; the main features being two retorts with a capacity of 100 tons per day, which operated on the same principle as the N-T-U, namely, internal combustion, but were continuous in operation instead of intermittent. This plant operated for two or three years, and is reported to have produced more than a million gallons of crude oil and marketed a wide range of refined products.

In California[2], the N-T-U Company erected and operated a plant near Casmalia consisting of four 40-ton retorts and which was in operation for about four years from 1923 to 1927, and during 1926 and 1927 produced about 160 barrels of shale oil per day. Both of the above plants ceased operations owing to the low price of crude oil caused by the excess production in the United States during the last few years.

SUMMARY.

During recent years, over three-quarters of the world's production of shale oil has been from Scotland. In other parts of the British Empire the production has been and still is negligible. The most promising deposits appear to be in Australia, but here, as elsewhere, low prices of petroleum products and high labour costs seem to stand in the way of successful exploitation. In

[1] *The Gas Engineer*, May 1927, pp. 112-3.
Railroad Redbook, Vol. 42, pp. 7-9 (1925).
Chemical & Metallurgical Engineering, Vol. 31, No. 20, p. 770 (1924).

[2] *Jour. Inst. of Pet. Tech.*, August 1926, p. 371.
Pet. Times, April 16, 1927.

World Production of Oil Shale.

Metric Tons.

Mineral Resources of U.S. and other publications.

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
New South Wales ...	25,861	21,341	33,009	23,844	1,226	652	—	—	—	—	—	—
Tasmania	610	142	882	41	1,119	1,601	853	2,161	3,201	2,637 (6,600)	4,368 (4,630)	— —
Esthonia	9,664	46,111	95,514	138,922	214,099	233,631	288,104	431,678	397,600	446,216	518,000	—
France	49,127	69,000	64,693	61,000	62,142	70,968	67,127	69,190	*	*	76,000	—
Germany (Bavaria)	—	—	—	33	1,202	530	400	10	480	670	603	—
Italy	10,563	16,325	3,030	5,476	5,662	2,987	2,700	10,290	12,090	7,388	1,331	—
Russia	4,533	30,366	19,300	18,500	29,799	11,684	1,130	4,095	9,434	562	—	—
Spain	5,527	*	*	*	*	*	67,500	*	54,337	54,110	54,900	—
Sweden	—	—	(328)	(353)	(158)	(nil)	(12)	(51)	(22)	—	—	—
England	620	1,750	—	—	71	—	—	—	—	—	—	—
Scotland	2,807,615	2,886,455	1,896,860	2,645,790	2,906,475	2,902,960	2,504,390	1,991,250	2,047,000	2,038,000	2,023,609	—
Canada	—	—	100—200?	—	—	26	—	—	—	100?	—	—
United States ...	*	8,875	2,062	*	9,300	21,209	*	5,500	7,600	1,928	1,767	—
Manchuria												
TOTAL	2,914,120	3,071,490	2,113,816	2,893,959	3,221,953	3,246,239	2,932,204	2,514,135	2,531,764			

*Data not available. Figures in brackets refer to Shale Oil.

Canada, as long as adequate supplies of cheap petroleum can be imported from the United States and abroad, there is no justifiable incentive to start development of oil shale deposits.

On the continent, the greatest advance seems to have been made in Esthonia, where the rapidly growing production may soon equal that of Scotland. In Esthonia, by far the largest part of the shale mined is burned directly as fuel. France and Spain seem capable of maintaining their production of 50 to 70 thousand tons of shale per year. Italy may substantially increase her annual production of 10,000 tons if developments in Sicily materialize, and as for Russia, it is very difficult to forecast future production.

Manchuria is by far the largest potential producer and if present operations are successful, the future output may possibly rise to five million tons of shale per annum, especially in view of the Japanese policy with regard to the fuel oil supplies for their navy.

In the United States, where interest was aroused in oil shales after the war, when a shortage of petroleum was feared, a great deal of development work was carried out. This has all ceased due to the unexpectedly large production of the recently discovered oil fields.

Generally speaking, at the present time, oil shales as a source of oil are somewhat under a cloud due to the over-production of crude petroleum, but they are to be considered a valuable reserve that may be drawn upon when economic conditions warrant their development.

Received 8th March, 1932.

OUTPUT OF CHEMICALS IN U.S.S.R.

During the first quarter of 1932 the output of the principal chemicals in the U.S.S.R. was as follows: Sulphuric acid—123,035 tons; superphosphates—165,632 tons; calcined soda—75,187 tons; caustic soda—19,996 tons.

As compared with the output of the corresponding quarter of 1931 the output of superphosphates has increased by 38.5 per cent., sulphuric acid by 23.9 per cent., calcined soda by 11.6 per cent., caustic soda by 6.5 per cent.

THE THERMITE REACTION WITH RHENIUM (DVI-MANGANESE) DIOXIDE.

By J. G. F. Druce, M.Sc.

The reduction of manganese dioxide to the metal has been effected by means of Goldschmidt's reaction (*Zeitschr, Elektrochemie*, 1898, *4*, 494) with aluminium.

The almost black rhenium (dvi-manganese) dioxide, obtained either as hydrate by reduction of per-rhenic acid with zinc and hydrochloric acid, or as the more compact (anhydrous) body left when the tetroxide, ReO_4, or heptoxide, Re_2O_7, is heated in a stream of hydrogen, has now been reduced in an analogous manner.

Reaction may be expressed by the equation,

$$ReO_2 + 4\ Al = 2\ Al_2O_3 + 3\ Re.$$

Six grams of rhenium dioxide were intimately mixed with 1.1 gr. aluminium powder (roughly the amounts demanded by the equation) and placed in a small Battersea crucible. The mixture was ignited by a fuse of magnesium and a vigorous reaction occurred although it was, perhaps not so violent as with manganese dioxide (Mn_3O_4 is generally used in the preparation of manganese metal). The flame which appeared on the top of the reacting substances was bright green (compare the platinum wire test, Druce & Loring, *The Chemical News*, *1925, 131, 337*).

The products of the reaction were separated by treatment first with dilute and then with strong hydrochloric acid. The rhenium (impure) remained as a dark amorphous mass although some of the aluminium oxide had fused. Since the melting point of rhenium is above 3,000° C. (Becker & Moers, *Metallwirtschaft*, 1930, *9*, 1063, give it as 3,400° Absolute), it is understandable that no ingot of rhenium could be obtained even at the high temperature developed in the thermite reaction.

The porous metal readily dissolved in warm dilute nitric acid to give per-rhenic acid. It also ignited on heating in the air and disappeared as a white cloud (of ReO_4). These reactions and its general appearance show that the substance obtained in the thermite reaction is identical with that obtained when rhenium disulphide reduced by heating in a stream of hydrogen.

THE STRUCTURE OF THE UNIVERSE.*

Professor William de Sitter, of Leiden, is considered an outstanding authority on the problems of mathematical astronomy. His greatest contributions are investigations on the motion of Jupiter's satellites and the generalized theory of relativity.

The subject of Dr. de Sitter's lecture at the Perkins Observatory was "The Structure of the Universe." There are two ways of obtaining information about the Milky Way, a part of which is a solar system. The first way is to study the Milky Way from inside. Since the days of Sir William Herschel, more than a hundred years ago, astronomers have been busy counting stars in various portions of the sky, making statistical investigations on stellar motions, brightness, spectra, colours, etc., in order to find out the structure of the Milky Way. Sir William Herschel himself, from the comparatively meagre material at his disposal, was able to arrive at some conclusions of great importance. The Milky Way, our galaxy, has the shape of a lens, being, so to say, compressed in one direction. Our solar system is moving in reference to the stars in its neighbourhood with a considerable velocity of twelve miles per second. Our solar system is not in the centre of the Milky Way, but cannot be very far from it.

With the advent of powerful telescopes and photography, these conclusions of Sir William Herschel have been confirmed. Furthermore, many more interesting facts about the Milky Way have been discovered. The number of stars in it must be enormous. The accepted estimate is some thirty to forty billions. Although the majority of them are too far away to be observed even with the most powerful telescopes, we can photograph millions and millions of them. The number of stars which can be photographed with the 100-inch Mt. Wilson telescope is about one billion. It is evident that we cannot study all of these. Our most extensive catalogues contain only a few hundred thousand stars, and about most of these our information is but fragmentary. Some method of selection of material for study is therefore necessary. In 1906 Professor Kapteyn of Groningen, a compatriot of Dr. de Sitter, put forward a plan of 206 "Selected Areas." These areas are distributed uniformly over the sky and constitute a fair sample of all stars. Various observatories all over the world co-operate in studying Kapteyn's areas.

The distances in our Milky Way are so great that it is impossible to find them by measuring stellar parallaxes. The apparent brightness of some variable stars (the Cepheids) is the only method available in fixing the dimensions of the Milky Way. The period of the variation in brightness of these stars depends on their actual brightness. Knowing their actual brightness and measuring their apparent brightness we can estimate their distance, provided that their light is not affected while traversing interstellar space. Dark obscuring matter will make the stars appear fainter and the estimated distances will come out greater. Preliminary results give 200,000 light years for the diameter of the Milky Way. Our solar system is some 50,000 light years from the centre which is in the direction of the constellation of Sagittarius. These figures, however, must be considerably reduced if the absorption of light in space is taken into account.

The Milky Way is in a rapid rotation about its centre. The sun takes only two hundred million years to complete one revolution, an interval very short on cosmic scale. Such rotation would produce a spiral structure. If we could look at the Milky Way from a great distance we would see a spiral nebula. Our Milky Way would be lost among millions of similar spiral nebulæ.

This is what Dr. de Sitter calls studying our Milky Way from outside. We cannot get away from our galaxy but we can study other galaxies and thus learn something about our own. It is true that in one respect our Milky Way differs from spiral nebulæ. The largest (and nearest to us) of these is only 30,000 to 40,000 light years across, whereas our Milky Way is at least five times as large. But we must not forget that we have reliable information of only about a dozen spiral nebulæ, and the largest among

* A summary of a recent lecture given by Dr. William de Sitter at the Perkins Observatory, Delaware, U.S.A.

them may still be undiscovered. On the other hand, it is very likely that the size of the Milky Way is greatly over-estimated.

The picture of the universe which the present day astronomy reveals to us is grandiose. Millions of spiral nebulæ are scattered through space, separated from each other by distances too great to comprehend. Each spiral nebula consists of billions of suns, of great diffuse bright nebulæ, of dark cosmic clouds, of clusters of stars. Is there a general plan according to which the universe is built?

Dr. de Sitter's own contributions to science may be called putting the universe in order. According to Einstein's theory time and space are merged together, and one depends on the other. This viewpoint does not make much difference in our terrestrial experience, but is of the greatest importance when we consider the enormous distances of spiral nebulæ. It is difficult to solve the intricate problem of the structure of the universe without making some assumptions as to the distribution of matter in it. Einstein proposed a theory of the universe based on the assumption that it is static, in other words there would be no appreciable change in it in the long run. De Sitter proposed another theory based on the fact that the universe is pretty nearly empty. The distances between stars and nebulæ are so great that if their matter is distributed uniformly through space the resulting density will be incredibly low. De Sitter's solution was considered nearer the truth because it accounted for the fact that the spiral nebulæ show large velocities in reference to our solar system. They run away from us, and their velocity of recession is proportional to their distance from us. One of the recently investigated nebulæ is receding from us at the rate of 12,000 miles per second.

De Sitter himself would be the last man to claim that his solution is correct. We know too little yet about the universe to build a consistent theory of its structure. Some five years ago Lemaitre, a Belgian priest, put forward another solution of this riddle. His solution is considered more nearly correct than that of De Sitter. According to Lemaitre the universe is continually expanding which accounts very well for the motion of the nebulæ. The difficulty lies in the great velocity of expansion. The universe has arrived at its present size only in a few billion years. We find that no time is left for the evolution of the earth, whose age is generally estimated at two to three billion years, let alone the stars and the galaxies which are, of course, much older formations.

The answer to these doubtful points may be given only by accumulating more of the observational material. Whether the universe is expanding or not, our knowledge about it certainly can expand. We are just beginning to learn something about the universe outside of the narrow confines of our Milky Way.

—N. T. Bobrovnikoff.
Assistant Professor of Astrophysics,
Ohio Wesleyan University, Delaware.

PROTECTION OF STEEL TANKS.

New Method for Preventing Corrosion.

By a well known Engineer.

Of great interest to chemical engineering is the recent recommendation of the American Railway Building and Bridge Association for the best method for protection of steel water tanks of all kinds.

This new method consists in using quick-drying Red Lead paint composed of 100 lbs. of Red Lead in oil, 1½ gallons boiled linseed oil, 3 pints turpentine, and 2 pints liquid dryer, and to each gallon of the paint so obtained 2 lbs. of finely powdered litharge is added immediately before application. One week also must elapse between the application of priming and the second coats, and 48 hours between the second and third coats, and after the latter has been allowed to dry for 48 hours the tank is ready for filling with water.

The recommendations of the Association are of course based on the most extensive experience in the protecting of railway plant and equipment of every description, including water tanks and water softening plant for example, while it must be emphasised that modern " non-setting " varieties of Red Lead enable the paint to be supplied in bulk

ready for use as it does not harden in storage containers.

This is due to the small proportion, not over 6 per cent. of free litharge (lead monoxide, PbO) contained in non-setting Red Lead (Pb_3O_4 Plumbic tetroxide) an effect produced by careful scientific control in the process of manufacture, that is oxidising molten lead with air in two stages, first to lead monoxide at not over 645° F. and second, at a higher temperature not over 1,000° F. in order to produce Red Lead. In this connection the British Standard Specifications require a minimum of 93.15 per cent. true Red Lead Pb_3O_4, and 99.5 per cent. total oxides of lead, with not over 6 per cent. litharge, while the American Society for Testing Materials Specifications are on the same lines.

The new suggestion of the addition of a small quantity of litharge to the paint immediately before application is certainly of interest but care should be taken to thoroughly mix as before.

It is well known of course as the result of the experience of more than a century that Red Lead possesses striking and valuable properties in protecting iron and steel against corrosion, especially in the case of sea water.

Familiar knowledge also is the fact that in the corrosion of steel, iron or other material by water, partly due to dissolved oxygen, the phenomenon known as "initial corrosion" takes place, that is the corrosion of the clean metal surface commences at a fairly rapid rate and then diminishes considerably, due to the formation of a protecting film of oxide. In this connection some notable American research work is that of R. H. Brown, B. E. Roetheli, and H. O. Forrest, described in a recent issue of *Industrial and Engineering Chemistry* (American Chemical Society, New York) in which these observers have determined with great accuracy the initial corrosion rates of aluminium, zinc, copper, nickel, tin, silver, and iron and steel. The method consists in the use of a small rotating cylinder of the metal which has been rendered oxide-free by treatment with hydrochloric acid and subsequently rinsed in a stream of oxygen-free water, until all traces of acid have been removed. The metal so treated is then subjected to the action of water containing dissolved oxygen, and the rate of corrosion measured by determining the decrease in the oxygen content of the water.

CO-ORDINATION OF SCIENTIFIC TERMINOLOGY.

Among the scientific questions which the International Institute of Intellectual Co-operation has been asked to examine there figures the co-ordination of scientific terminology.

Various international organisations, including the Commission of Electro-technics and certain scientific Unions, have undertaken, each in their respective sphere, the compilation of scientific or technical vocabularies. The different branches of science, however, constantly employ, and very often with a different meaning, terms which are common to all of them. It therefore appeared indispensable that the coordination of these terms should be undertaken.

For this purpose, a Committee recently met at the International Institute of Intellectual Co-operation. It was composed of Professor CABRERA (Madrid), Chairman; Professor COTTON (Paris), representing the International Union of Physics; Professor WILLSTATTER (Munich); Professor LOWRY (Cambridge), delegates of the International Union of Chemistry; Professor SELYS-LONGCHAMPS and Dr. LEDOUX (Brussels), representing the International Union of Biological Sciences, and Professor LOMBARDI (Rome), delegate of the International Union of Electro-technics.

The Committee unanimously recognised the capital importance attaching to the unification of scientific and technical terminology common to several branches of science and invited the International Institute of Intellectual Co-operation to undertake this work in conjunction with the International organisations concerned.

FLOODLIGHTS ON PHOTOGRAPHY.

Floodlights on Photography is the title of an attractive and interesting booklet just issued by Burroughs Wellcome & Co., London, E.C.

The striking cover in blue, black and aluminium carries illustrations of floodlighting effects photographed during the Faraday Centenary Celebrations of last autumn. In the text several fine scenes are shown to advantage in colour.

The subject matter deals with methods for obtaining correct exposure by means of the 'Welcome' Exposure Calculator, factors that influence development, and the improvement of prints by toning and staining. The fact that development is a precise operation is given due emphasis. The use of 'Tabloid' Desensitiser and the universal developer, 'Tabloid' 'Rytol,' greatly simplifies the process.

If some negatives are too dense or underexposed, reduction or intensification can be carried out with 'Tabloid' Potassium Ferricyanide Reducer or 'Tabloid' Chromium Intensifier.

In the section dealing with toning and staining of prints, methods are given for the production of realistic colour effects by means of 'Tabloid' Toners and 'Soloid' Stains.

A copy will be sent free on application to Burroughs Wellcome & Co., G.P.O. Box No. 213a, London, to all readers mentioning this journal.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

APPLICATIONS FOR LICENCES IN MARCH, 1932.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during March has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 414, of which 355 were from merchants or importers. To these should be added 7 cases outstanding on the 29th February, making a total for the month of 421. These were dealt with as follows:—

Granted—400 (of which 389 were dealt with within 7 days of receipt).

Referred to British makers of similar products—20 (of which 19 were dealt with within 7 days of receipt).

Outstanding on 31st March—1.

Of the total of 421 applications received, 408 or 97 per cent. were dealt with within 7 days of receipt.

OBITUARY.

PROFESSOR WILHELM OSTWALD.

We regret to announce the death of Prof. Wilhelm Ostwald at Grossbothen, in Saxony, at the age of 78.

Born at Riga, he became Professor of Physical Chemistry and Director of the Physical Chemical Institute of Riga University, receiving the Nobel Prize for Chemistry in 1909. Ostwald received the honorary degree of D.Sc. from the University of Cambridge. During the middle of his very busy life, this famous savant devoted himself more to questions of natural Philosophy, such as the energy resources of the World. These studies, the fight against scientific materialism, and the propagation of Haeckel's monistic philosophy so occupied his mind that he gave up his professional duties in 1906 and retired to his country seat in Grossbothen, Saxony. There he created for himself a fresh sphere of activity. Starting from the Art of Painting, which he had cultivated since his youth, he worked out a new system of colour, by which every tint can be characterised by exact figures. He expounded the system in various books on colours and it led to the foundation of an institute for colour investigation in Dresden.

Professor Ostwald was a prolific writer and among other journals, *The Chemical News* published many of his articles between Volume 47 and Volume 99. Some were individual work and others prepared with the assistance of collaborators.

Ostwald was co-author with Findlay of *Principles of Inorganic Chemistry*, Co-Editor with van't Hoff, of *Zeitschrift für Physikalische Chemie* (Journal of Physical Chemistry), and was the author of many other works.

By Ostwald's death, the world loses a great investigator, thinker, teacher, organiser and reformer, and those of us who were fortunate to have known him and call him counsellor and friend feel that loss sorely.

H. W. BLOOD RYAN.

A TRIBUTE TO THE LATE PROF. EDGAR FAHS SMITH. 1854-1928.

The April number of *The Journal of Chemical Education* is an Edgar Fahs Smith Memorial Number and *The Chemical News* gladly joins in paying tribute to the memory of this distinguished American Man of Science.

Of the 170 original articles and contributions dealing with his own researches, Prof. Smith published no less than 60 of them in *The Chemical News.* They cover the period from 1880 right up to 1928 and deal with many problems in inorganic and electrolytic chemistry which Prof. Smith's work went far to elucidate. His last paper dealt with the soluble meta-tungstates, inorganic bodies of unusual complexity and whose exact nature is probably not yet known with absolute certainty.

Prof. Smith's energy and capacity for work must have been enormous for in addition to all his scientific investigations he found time to write a dozen important text-books, all standard works in their time and some running through many editions and still being used by the present-day generation of students.

Moreover, as a Biographer he has done much to popularise an interest in the history of science both in America and throughout the world. His biographies of Robert Hare, James Woodhouse, Joseph Priestley and others are important contributions to the history of chemistry as are also his works on the beginnings of our science in America.

As a writer in the *Journal of Chemical Education* points out, this colossal output of scientific work was only possible through the untiring thoughtfulness and care of his devoted partner, Mrs. Margie A. Gruel Smith, who took such a pride in the brilliant career of her distinguished husband, helping him and sharing with him the enthusiasm for his work. Honours and distinctions were plentifully and justly bestowed upon Prof. Edgar Fahs Smith, especially after the turn of the century.

This same number of the *Journal of Chemical Education* also contains a symposium on the History of Chemical Education in America—a subject after the late Professor's own heart.

Proceedings and Notices of Societies.

THE FACULTY OF SCIENCES.

The following candidates were elected to the Fellowship of the Faculty of Sciences at the Council Meeting held on 8th April, 1932.

Bertram Baden
Harold Guest
John Alexander Heath
Cecil Edward Harris
James Smith
Morris Charles Lamb
Herbert Wardle Clarke
Thomas Francis Doyle
Reginald Francis Moon
James Harry Smith
Maureen J. C. Crowley
Albert William Peters
Hugh Herbert Orr
Randolph Granville Wood
Arthur French Angell
Alfred George Anderson
Ambrose John Cruise
George Albert Smy
Cyril Ernest Gill
Alan Hamilton Bateman
Albert Thomas King Moir
Francis John Salkeld
Philip Walter Alloway
John Bate Nickolls
Frederick Charles Bird.

THE PHYSICAL SOCIETY.

At the annual general meeting of the Physical Society held on March 18th, 1932, the following officers were elected. *President*, Professor A. O. Rankine, O.B.E., D.Sc., F.Inst.P.; *Vice-Presidents who have filled the office of President*, Sir Oliver J. Lodge, D.Sc., LL.D., F.Inst.P., F.R.S.; Sir Richard Glazebrook, K.C.B., D.Sc., F.Inst.P., F.R.S.; Sir Arthur Schuster, Ph.D., Sc.D., F.Inst.P., F.R.S.; Sir J. J. Thomson, O.M., Sc.D., F.Inst.P., F.R.S.; Professor C. Vernon Boys, F.Inst.P., F.R.S.; Professor C. H. Lees, D.Sc., F.Inst.P., F.R.S.; Professor Sir W. H. Bragg, K.B.E., M.A., F.Inst.P., F.R.S.; Dr. Alexander Russell, M.A., F.Inst.P., F.R.S.; Sir Frank E. Smith, C.B., D.Sc., F.Inst.P.; Sec.R.S.; Professor O. W. Richardson, M.A., D.Sc., F.R.S.; Dr. W.

H. ECCLES, F.Inst.P., F.R.S.; Professor SIR ARTHUR S. EDDINGTON, M.A., D.Sc., F.R.S.; *Vice-Presidents*, Dr. A. B. WOOD, D.Sc., F.Inst.P.; and Mr. T. SMITH, M.A., F.Inst.P.; Dr. J. S. G. THOMAS; Mr. J. GUILD, A.R.C.S., D.I.C., F.Inst.P.; *Secretaries,* Dr. EZER GRIFFITHS, F.Inst.P., F.R.S. (Business); Dr. ALLAN FERGUSON, M.A. (Papers); *Foreign Secretary,* Professor O. W. RICHARDSON, M.A., D.Sc., F.R.S.; *Treasurer,* Mr. R. S. WHIPPLE, M.I.E.E., F.Inst.P.; *Librarian,* Dr. J. H. BRINKWORTH, A.R.C.S.; *Ordinary Members of Council,* Dr. LEWIS SIMONS, F.Inst.P.; Mr. J. H. AWBERY, B.Sc., F.Inst.P.; Professor J. A. CROWTHER, M.A., Sc.D., F.Inst.P.; Dr. W. JEVONS, D.I.C., F.Inst.P.; Professor W. WILSON, Ph.D., D.Sc., F.R.S.; Dr. D. OWEN, B.A., D.Sc., F.Inst.P.; Miss M. O. SALTMARSH, Ph.D., F.Inst.P.; Major I. O. GRIFFITH, M.A.; Professor H. R. ROBINSON, F.Inst.P., F.R.S.; Professor G. F. P. TEMPLE, Ph.D., D.Sc.

SOCIETY OF GLASS TECHNOLOGY.

The following papers were read on March 16th, 1932.

The Reaction Between Calcium Carbonate and Silica, By W. MASKILL, B.Sc., G. H. WHITING, B.A., Ph.D., and Professor W. E. S. TURNER.

In his introductory remarks, Professor Turner referred to the work reported in an earlier paper, dealing with the reaction between sodium carbonate and silica. The aim of the present work had been to investigate the reaction between calcium carbonate and silica of definite, small grain size, at various temperatures, the substances used being pure, in the form of calcite and crushed rock crystal.

It was found that, at 700°, the decomposition of calcium carbonate was accelerated by the addition of silica, the acceleration increasing when the proportion of silica was increased from one to three molecules per molecule of calcium carbonate. At 750°, and 800°, however, the addition of silica in the proportion of SiO_2 : $CaCO_3$, produced very little change, although, as the silica content of the mixtures was increased, acceleration took place. Analysis showed that very little reaction had taken place between the carbonate and silica at these temperatures.

It was obvious, from the results obtained, that this acceleration was not due to increased chemical activity, but to a physical effect. The silica diluted the calcium carbonate, allowing of a quicker diffusion of carbon dioxide, and hence aiding the decomposition.

The mixtures were analysed chemically after the heating treatment, the method of analysis being described in some detail.

It appeared that, at 800°, about 4 per cent. reaction had occurred, between the silica and the carbonate; the value at 1,050° was 10 per cent.; while the reaction was almost complete at 1,400°—1,450°.

Turning to a consideration of the actual behaviour of silica and limestone in a glass batch, the Professor showed that, from this research, it was evident that the calcium carbonate was split up, or decomposed primarily by heat alone.

The Effect of Glass on a Commercial Glass Containing Lead Oxide. By J. H. PARTRIDGE, B.Sc., Ph.D. (Communication from the Staff of the Research Laboratories of the General Electric Co. Ltd., Wembley).

Dr. Partridge described how the surface of a commercial lead oxide glass (30 per cent. PbO; 56 per cent. SiO_2) soon lost the mirror-like appearance when exposed to the atmosphere existing in an oil fired tank furnace at 1,200°. In two or three weeks time the glass became cordy and lumpy, and the surface was dull, with small lumps of a white substance sometimes present. The white deposit was found to be mainly cristobalite. The application of heat alone at the temperatures concerned did not cause this precipitation, and the only gas which had any visible effect on the glass was sulphur dioxide.

At a temperature of 1,200° in special experiments, this gas caused separation of silica on the glass surface, identical in crystalline form with that obtained in the tank, but in presence of oxygen, a complex mixture of the sulphates of the alkalies and lead separated out with the silica. The atmosphere from burning fuel oil containing 1.7 per cent. sulphur also gave this result,

which, however, was less marked when paraffin with only 0.04 per cent. of sulphur was used instead of the fuel oil. It was found, when trying to achieve a greater stability of the glass in presence of sulphur dioxide, that the addition of a small amount of boric oxide rendered the glass more resistant than the parent glass.

The speaker stated that he had discussed these results with Professor Parmalee of the University of Illinois, who had observed a somewhat similar phenomenon in the case of enamels. Professor Parmalee had not been able to identify the composition of the surface film but he detected sulphur in the enamel, and Dr. Partridge, as a result of this suggestion, had found sulphur in the surface deposit on one of the glasses studied. Possible theories to explain the action of sulphur dioxide were discussed.

The author expressed his thanks to his colleague, Mr. H. P. Rooksby, B.Sc., who detected cristohalite in the surface films on the glasses.

Volatilisation from Potash Lead Oxide Glasses and its Bearing on the Corrosion of Glass Melting Pots. By E. Preston, B.Sc., and Professor W. E. S. Turner.

The process of volatilisation from the surface of a molten lead glass, initially homogeneous, had been studied. The influence of temperature and time upon the progress of volatilisation was shown in tabular and graphical form over a range of temperature 900° to 1,400°, and for times extending to 200 hours. It was shown that volatilisation of the volatile constituents of a glass took place in a manner similar to simple evaporation, the rate of volatilisation at any time being proportional to the partial pressure of the volatilising constituent or constituents. This fact was directly proved over the range 1,100° to 1,350° by actual determinations of the vapour tensions of the volatilising material, by the dynamic inert gas method, and by utilising the previous information, the scale of vapour pressures of the volatilising PbO in this glass was extended from 0.005 m.m.Hg. at 900° to 6.50 m.m.Hg. at 1,400°.

The bearing of the work upon the corrosion of glass house pots used for melting full crystal glass was discussed. The results of tests upon the crown and jib of corroded pot simples showed that the slagged interior surface of these samples were rich in PbO and K_2O. Penetration of lead oxide and potash into the refractory took place to a slight extent. It was suggested that high temperature firing of the pot as a whole, provided the refractory was suitable, might offer a partial remedy by reducing porosity and increasing the resistance to the slagging action of the lead oxide and potash vapours.

Information was furnished concerning a melt of this lead glass in a cylindrical slipcast crucible for 100 hours at 1,350° C. Resulting analyses of sections of the glass showed the establishment of a concentration gradient of PbO from approximately 30 per cent. PbO at the bottom of the pot to less than 15 per cent. PbO at the upper surface, due to simultaneous volatilisation and diffusion of the PbO. This showed once more that a uniform temperature distribution was a factor entirely opposed to the production of homogeneous glass when volatile constituents were present such as PbO, K_2O and Na_2O.

BRITISH ASSOCIATION OF CHEMISTS.
NOTICES.

Notts & Derby. The Annual Meeting of the Section will be held on 9th May in Derby. Mr. A. E. Knapp, M.Sc., F.I.C., has consented to give an address on the organisation of the profession. An informal meal will be arranged. Visitors are cordially invited. Several committee members retire under the three-year rule and nominations for new members will be welcomed; these should be sent to the Hon. Secretary before 18th April.

B.A.C. members are invited to an S.C.I. Meeting on Thursday, 21st April, at 7.30 p.m., at Derby Technical College when Mr. J. A. Clements, F.I.C., A.M.I.Chem.E. (of the Brown-Firth research labs.) will give an address on "Recent improvements in non-corrosive steels for domestic and industrial uses," illustrated by lantern slides." Please carefully note this date.

Scottish. The Annual Meeting of the Section will be held on Friday, 22nd April, at 7.30 p.m., in the Central Halls, Bath Street, Glasgow.

Birmingham. The Annual Meeting of the Birmingham Section will be held at the Chamber of Commerce, New Street, Birmingham, at 7.30 p.m. on Tuesday, 10th May.

London. The Annual General Meeting of the London Section will be held on Friday, 6th May, 1932, at 7 p.m. This will be followed by a Smoking Concert at 8.15 p.m. and it is hoped members will make a special effort to attend with their friends.

Notices of Books.

A textbook of Organic Chemistry, by PROF. JULIUS SCHMIDT, Second English Edition (revised and extended), by DR. H. GORDON RULE, xxiv + 843. London: Gurney & Jackson, 33, Paternoster Row, E.C. 1932. Price 25s.

This comprehensive and masterly translation of Prof. Schmidt's *Organic Chemistry* has been considerably extended and revised on the occasion of the publication of the second English edition. The book not only covers a systematic account of the aliphatic and aromatic compounds but considerable space is devoted to the discussion of a number of interesting and topical subjects such as the recent work on addition to conjugated systems, the electronic theory of valency, the mechanism of racemisation, epimerisation, enantiomorphism, asymmetric decomposition, spiro-compounds, the stereochemistry of nitrogen and sulphur, the Beckmann re-arrangement, the parachor, the polar properties of organic salts and other physico-organic matters.

Among the extensions necessitated by the recent advances of the last few years are those dealing with the sugars and other carbohydrates, purines, terpenes, sterols, the alkaloids and the proteins. New sections have been added to deal with such points as the synthesis of methyl alcohol, the phosphatides, enzymes, etc.

Inclusive as this volume is, there are still some sections that are dismissed very briefly. Thus, the account of the organo-metallic compounds is compressed into five pages and no description is given of a whole series of these bodies whose significance and importance is being more and more recognised.

Nevertheless this textbook has, on the whole been so well done and is so well illustrated that it can be strongly recommended to the attention of all organic chemists.

Bibliography of Ethylene Dichloride, by W. A. GERSDORFF, Assistant Chemist, Insecticide Division, Bureau of Chemistry and Soils, U.S. Department of Agriculture, Washington, D.C., Publication 117, Feb. 1932. 10 cents.

Mr. Gersdorff is in a singularly strong position as the compiler of this Bibliography. It presents in neat and concise form abstracts of papers published on this subject, so that the contents of this pamphlet is rather more than the title leads one to expect. In addition to the bibliography itself, the compiler has prepared an index of subject matter and the work closes with a chronological index.

In 1795, the Dutch chemists, Deimann, Van Troostwyk, Bondt, and Louwrenburgh, first reported the preparation of a liquid from chlorine and ethylene. This liquid was known for some years as the "oil of the Dutch chemists," and by various other names until it was given its present name of ethylene dichloride, or, more properly, 1, 2, or s-dichloroethane. In English it has been called, besides "oil of the Dutch chemists," elayl chloride, and ethylene chloride. In addition to the equivalents of these names, the Germans and the French have called it Chloräther in Maximum von Chlor, Atherinchlorid, Oel des oelbildenes Gases, chlorwasserstoffsaures Chlorätheras, Chlorkohlenwasserstoff, Aethenchlorür, Chloräthylen, hydrocarbure de chlore, and chlorhydrate de chlorure d'aldehydene (ou d'acetyle).

Ethylene dichloride, $CH_2Cl.CH_2Cl$, is a colourless liquid with an odor hardly distinguishable from that of chloroform. It has the following physical properties (Mellon Institute): Boiling point, 83.5° C. at 760 millimeters; melting point, — 36°; flash point (Abel-Pensky), 12-13°; density at 20/4°, 1.2569; specific heat, 0.3054 at 30°; latent heat of evaporation, 157.5 British thermal units per pound at 0°.

Ethylene dichloride is a good solvent for oils, fats, waxes and certain alkaloids, gums, resins, and rubber. It is extremely stable in the presence of water, alkalies, acids and active agents, such as free chlorine, sulphuryl chloride, and sulphur monochloride. It is resistant to oxidation. It does not corrode metals even in the presence of water at the boiling point. At ordinary temperatures, it burns with such difficulty that when ignited the draft of combustion will blow out the flame.

The physiological action of ethylene dichloride is comparable to that of chloroform.

The chief use of ethylene dichloride has been that of a solvent, and as such it is of great value. Recently, it has been shown to be of value for insecticidal purposes. Cotton and Roark in 1927, and Hoyt in 1928 obtained 100 per cent. kills with a 3 : 1 ethylene dichloride-carbon tetrachloride fumigant. The advantages of this fumigant are: Effectiveness, relative cheapness, simplicity in use, ease of removal, absence of fire hazard, and safety for human beings.

Ethylene dichloride may now be obtained in the pure state at reasonable cost.

This little work will be found to be useful to all chemists, particularly to those engaged in the refrigeration and insecticide industries.

H. W. B. R.

Kolloidchemie der Seifen, by DR. E. L. LEDERER, Pp. xvi + 430 with 74 illustrations and numerous tables. Dresden and Leipzig: Theodor Steinkopff. 1932. Price 38 marks.

Dr. Lederer's authoritative monograph on the colloid chemistry of soaps forms Vol. V of the series on colloid science published by Messrs. Steinkopff and is dedicated to Prof. Wilhelm Ostwald the general editor of this series. This volume affords another instance of the useful application of recent developments in colloid chemistry to industrial and technical uses. The many types of soaps have the common property of all being readily made into colloidal gels and of emulsifying with other substances—upon which their qualities as cleansers depend. The crystalline, gel and sol forms are all described in detail, especially in connection with their behaviour towards electrolytes and non-electrolytes. adsorption phenomena and the theory of the action of soap occupy another lengthy chapter.

The 'metal soaps' and other analogous products are not overlooked and there is an interesting chapter on the physiological action of soaps.

A feature of the book is the wide range of tabular matter relating to all aspects of the properties and behaviour of soaps of the various fatty and other acids. So much has now been done in connection with the study of soap colloids and the important bearing of this knowledge upon the manufacture and uses of soaps for general and special uses cannot be over-estimated. Dr. Lederer's contribution to the literature of soap technology will be welcomed by chemists and all interested in soap-making and soap-using.

Fettberichte (A complete Survey of the Literature of Fats and Fatty Products for 1927, 1928, 1929 and 1930), By Dr. J. Davidsohn and K. Rietz. Pp. xvi + 458 Stuttgart: Ferdinand Enke. 1932. Price 47 marks.

Dr. Davidsohn and Herr Reitz have attempted (and attained) a complete survey of the scientific and technical literature upon Fats, Oils and related Products for the last few years. The ever increasing volume of literature in pure and applied chemistry has presented the authors with a gigantic problem in tracing and noting down all the articles and publications on the one subject of Fats. They have had to refer to no less than 473 different journals and the total number of annotated references must be not less than 5,000, apart from hundreds of patents. There are 2,400 authors mentioned in the 20-page, closely-set Name Index and during the period covered by this comprehensive bibliography these authors have worked intensively upon all sorts of problems which have led to revolutionary changes in soap-making, colloid technology, emulsion making and in many important industries associated with the use of animal and vegetable fats and fatty substances.

The position of the specialist who has a large library close at hand is hard enough at the present time as regards keeping abreast of the latest developments. The position of the man in a provincial district with no library catering for his requirements is unenviable, for though he belong to all sorts of societies and he carefully peruses the Abstracts issued by the Chemical Societies he may well miss much of extreme value and interest.

So far as the field of Fat Chemistry and Technology is concerned this difficulty has been solved by the present compilation by these German specialists. Their *Fettberichte* is indispensable to all engaged in the industry and to many outside it.

J. G. F. D.

New Patents.

These particulars of New Patents of interest to readers have been selected from the Official Journal of Patents and are published by permission of the Controller of H.M. Stationery Office, and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

Specifications Published.

369,461.—Bamag-Mehuin Akt.-Ges.—Ozone generator.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, at the uniform price 1/- each.

Abstract Published.

Group Abridgments can be obtained from the Patent Office, 25 Southampton Buildings, London, W.C. 2, either sheet by sheet as issued on payment of a subscription of 5/- per Group Volume or in bound volumes price 2/- each.

364,418.—Acetylene.—Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij, 30, Carel van Bylandtlaan, The Hague.—(Assignees of Millar R.W.)

Hydrocarbons are decomposed, particularly to acetylene, by means of an inverted flame produced by the introduction of oxygen or an oxygen containing gas into an atmosphere of the entirely gaseous hydrocarbon in the absence of liquid or under the surface of the liquid hydrocarbon to be decomposed. The oxygen or oxygen containing gas is introduced through one or more jets into a vessel through which the hydrocarbon is caused to flow. Examples are given of the burning of oxygen or air in a stream of natural gas and of oxygen under the surface of gasoline. Kerosene, lubricating oils, etc., are treated in the same way. More acetylene is produced per unit of oxygen consumed when the jets are of small diameter and when arranged as a plurality of jets in a group in a single vessel. Specifications 264,845 and 265,234, [both in *Class* 2 (i), Acetylene], are referred to.

The Latest Trade Marks.

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of H.M. Stationery Office, and the Trade Marks Journal can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

TRAQIT.

529,774.—Chemical substances used for manufactures, photography or philosophical research and anti-corrosives.—Hubert Chase Mason, 211, Addiscombe Road, East Croydon, Surrey. March 30.

ABRACIDE.

529,600.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—A Boake Roberts & Company, Limited, 100, Carpenter's Road, Stratford, London, E. 15. March 30. (Associated).

THE CHEMICAL NEWS

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THE DISCOVERY OF RHENIUM (DVI-MANGANESE)*

By J. G. F. DRUCE, M.Sc.(Lond.), R.Nat.Dr.(Prague), F.I.C.

Dr. Blood Ryan in introducing Dr. Druce said:—

Dr. Druce needs no introduction to many of us—his researches have not been confined to this country alone, and for his work on behalf of science abroad, he has received the coveted honorary membership of the Masaryk Academy of Work of Czechoslovakia. Dr. Druce is fully alive to the aim of our movement.

The history of the discovery of the various elements is intriguing; as witness the search for the elusive element 87 (Eka-Cæsium) scientists to the number of five from different countries are seeking to isolate this element but I am inclined to think that owing to 87's volatility their search will be in vain.

Since the war much attention directed to the structure of the atoms and Moseley's work on Atomic numbers led to revival of interest in the Periodic Classification of the Elements. Druce and Loring were engaged upon looking for an element, similar to manganese, which should be heavier than Uranium and which should thus be beyond the present limit of atomic number 92. In 1922 Coster and Hevesey in Copenhagen discovered hafnium. Priority was disputed by Urbain of Paris who claimed to have found it in 1911-12 through spectrum analysis. Spectrum analysis played a great part in the discovery of Manganese homologues. Their discovery was made independently in three countries,

Druce and Loring in England
Noddack, Tacke and Berg in Germany
Heyrovsky and Dolejsek in Czechoslovakia.

Whilst the English and Czechoslovak scientists kept to Mendelejev's provisional name, dvi Manganese, the Germans called the new element of atomic number 75, Rhenium.

* Substance of a lecture delivered before the Faculty of Sciences, at its Rooms on 12th April, 1932, the President in the Chair.

LECTURE.

When Mendelejev in 1869 enunciated his Periodic Law and drew up his Table of the Elements he left a number of blank spaces for elements then unknown but which he confidently predicted would ultimately be discovered. It is remarkable that his detailed forecasts of the then missing eka-boron, eka-aluminium and eka-silicon were brilliantly verified within a few years by the discoveries of Scandium (Nilson, 1879), Gallium (Lecoq de Boisbaudran, 1875) and Germanium (Winkler, 1886).

Concerning the homologues (or congeners) of manganese, Mendelejev had little to say beyond that they were expected to resemble manganese in general chemical behaviour. Efforts to identify these missing elements were, for a long time, unsuccessful. Nevertheless a host of alleged new elements were reported but none of them could be verified and none were recognised.

In 1898 Hartley and Ramage, after a spectroscopic examination of a large number of minerals, declared that the existence of the missing elements was improbable. As late as 1924 Bosanquet and Keeley could find no trace of any new element in pyrolusite (MnO_2) by a method of cathode ray bombardment but in the following year the discovery of dvi-manganese was made independently in 3 countries (Noddack, Tacke and Berg in Germany; Druce and Loring in England, and Heyrovsky and Dolejsek in Czechoslovakia).

In their first paper the German investigators refer to Loring's declaration (*The Chemical Elements,* by F. H. Loring, Methuen, 8s. 6d.) that these missing elements, having odd atomic numbers, would, like scandium, exist in only small amounts. They go on to say that according to their views these elements should be present in platinum ores and in such minerals as columbite.

From these sources and by a most complicated series of treatments, for details of which their original papers must be consulted, they obtained a product in which Berg found the X-ray spectral lines of 43 and 75 and they promptly named these elements, Masurium and Rhenium after Masurenland & Rheinland, the east and west provinces of Germany.

Loring and Druce then published their work on the search for element "93," (*The Chemical News,* 1925, *131,* 273 and 337).

These researches had led to the discovery of dvi-manganese in crude manganese salts and in pyrolusite. The new element was isolated as the impure oxide which showed characteristic reactions which are still used to identify it. The X-ray spectra showed the expected lines for the element of atomic number 75 and there was some evidence of the presence of other hitherto undiscovered elements, notably eka-cæsium. The discovery of dvi-manganese in manganese compounds was confirmed by the Czechoslovak investigators who detected the new element in manganese sulphate solutions by means of Heyrovsky's polarograph method with a dropping mercury cathode. In the meanwhile Zvjaginstsev, who has had great experience at the Russian Platinum Institute, declared that he could find no new element in native platinum and that if any were present it was in amounts less than 0.003 per cent. Also, Prof. Prandtl, who had spent his life in studying the rare earth minerals, especially columbite, stated that a re-examination of this mineral with the help of Drs. Grimm and Francke failed to reveal any trace of dvi-manganese and it is significant that the Noddacks have since used molybdenum glance as their source for rhenium. It is from molybdenum residues that the metal is now prepared commercially by the Vereinigte Chemischer Fabriken of Leopoldshall. The method given in the published patent specification is, however, still very complicated and although evidently quite successful, it does not seem rational.

Of Masurium little is now heard. Some spectral lines have been identified but no compound (or the free element) has yet been isolated.

All the dvi-manganese, or rhenium as it has come to be called, used in the English researches has been derived from pyrolusite and manganese salts—according to the methods already published in *The Chemical News.* Altogether some 300 lbs. of material have been worked up. The rhenium content has been estimated at about one part in

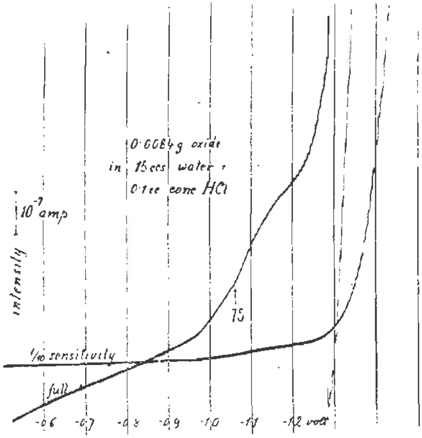

Fig 1.
POLAROGRAPH OF THE ORIGINAL PREPARATION FROM CRUDE MANGANESE SULPHATE.

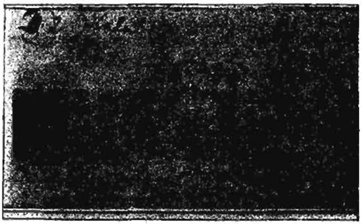

Fig. 2.
X-RAY SPECTRUM OF AN EARLY PREPARATION SHOWING THE LINES OF "75."

10,000-20,000. Under 10 grams of elementary rhenium have thus been available but study the physical and chemical properties of the element and its more important compounds.

The dark, almost black residue obtained best by reducing the sulphide in hydrogen is a heavy metal. Its melting point has been given as well over 3,000° C. It burns readily in air, is soluble in nitric acid, but other

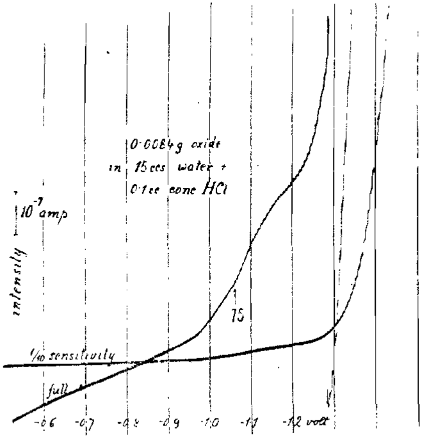

Fig 1.
Polarograph of the Original Preparation from Crude Manganese Sulphate.

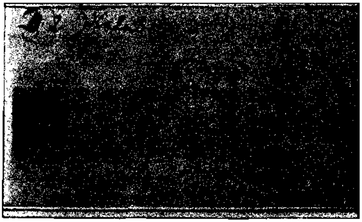

Fig. 2.
X-Ray Spectrum of an Early Preparation showing the lines of "75."

10,000-20,000. Under 10 grams of elementary rhenium have thus been available but study the physical and chemical properties of the element and its more important compounds.

The dark, almost black residue obtained best by reducing the sulphide in hydrogen is a heavy metal. Its melting point has been given as well over 3,000° C. It burns readily in air, is soluble in nitric acid, but other

acids have little action upon it. It combines directly with chlorine and reacts with alkalis to give possibly rhenates which readily oxidide to colourless per-rhenates. Its atomic weight has been found to be 186.3. No less than six oxides have been reported. the dioxide and the heptoxide are the commonest. The former is the only one showing any basic properties whilst the latter is the anhydride of per-rhenic acid, many stable salts of which are known. Potassium perrhenate is perhaps the commonest compound since it is readily obtained pure owing to its slight solubility in cold water.

Rhenium disulphide and heptasulphide are known and there are numerous halogen compounds. The tetrachloride has been combined with other metal chlorides to form double salts.

Since rhenium salts were available commercially about a year ago, a number of German chemists, and also Prof. Briscoe and his students in this country, have investigated its reactions more fully.

Coinciding with the experience of Loring and Druce it is being realised that rhenium shows more affinities with molybdenum and osmium than with manganese. This is apparent from a consideration of its oxides, stable acidic compounds and its halides.

Few of these compounds are yet, however, of more than academic interest although both the free element and its oxides have been tried and patented as catalysts.

Dr. Druce then gave a survey of the literature on rhenium.

THE STORY OF THE PERKINS REFLECTOR.

An account of the Perkins Gift, and the manufacture of the mirror and mounting for the world's third largest telescope.

The completion of the 69-inch mirror for the Perkins telescope brings to fruition the plans of the late Professor Hiram Mills Perkins of ten years standing.

Professor Perkins, who for many years was Professor of Mathematics and Astronomy at Ohio Wesleyan, gave to the University shortly before his death approximately $200,000 to build an observatory which would house a telescope of the first magnitude. This was in addition to the older observatory of instruction, containing a 9½ inch refractor and the usual equipment for instructional purposes, which is situated near the college campus. An additional gift from Professor Perkins' relatives started an endowment to maintain the Director's salary and to provide additional equipment.

The new observatory is located four miles south of Delaware and about fifteen miles from the grounds of Ohio State University. Ground for the Perkins Observatory was broken in May, 1923, Professor Perkins himself turning the first sod.

The huge mirror weighing 3,000 pounds, and with a replacement value of $50,000, was placed in position on the telescope on December 14, 1931. Eight years of toil and patient waiting have at last brought together the mechanical requirements necessary to the operation of the second largest telescope in the United States, and the third largest in the world.

The telescope was originally designed to contain a 60-inch mirror, but upon realization that there were in existence two or three even this amount has proved adequate to other telescope mirrors of 60-inch diameter, Professor Perkins insisted that the telescope for Ohio Wesleyan should exceed all other telescopes in America except the 100-inch at Mt. Wilson, and the plans were altered during the construction to provide for a 61-inch mirror. It appeared desirable to those concerned with the early plans that the large optical parts should be made, if possible, in America, and various glass manufacturers were consulted in efforts to obtain such a disc as would be suitable for astronomical purposes, and to be not less than 61-inches in diameter. After carefully considering the difficulties involved in casting a glass disc of such huge proportions, the glass manufacturers were unwilling to attempt the contract. Through the solicitation of scientific friends, the U.S. Bureau of Standards, then under the direction of the late Dr. S. W. Stratton, agreed to undertake the making of such a disc as a piece of research in American glass making in the optical shops of the bureau at Washington.

After four unsuccessful attempts to obtain a satisfactory pouring of glass for a

disc 61 inches in diameter, the mould was enlarged, modifications introduced in the procedure, and a pouring of borosilicate glass was made in May, 1927, which resulted in a disc of glass 70 inches in diameter. To assure the perfect annealing so necessary in optical glass making, the huge disc was allowed to cool so slowly that eight months elapsed before it attained the temperature of the surrounding room and could be safely opened to view. During these long tedious weeks of waiting the glass was constantly observed day and night, and readings of its temperature taken at fifteen-minute and later half-hour intervals. The mould was finely broken open and the disc of glass exposed on January 21, 1928. The disc was then tested as to its quality for optical purposes and found satisfactory. Much credit is due to the Bureau of Standards for its part in making possible the completion of the Perkins telescope.

The glass disc was removed from the optical shops at Washington to the factory of J. W. Fecker, at Pittsburgh, for grinding and polishing. Careful examination of the large disc showed that a mirror of 69-inch diameter could be finished from the crude glass, and that to cut it down to the contemplated size of 61 inches would be a serious waste of skill which might not be duplicated. After careful consideration, the trustees of Ohio Wesleyan signed the contract with the J. W. Fecker Company on February 13, 1929, for the execution of a finished mirror of as large dimensions as could be satisfactorily made from the unground disc. Work was begun on the grinding of the disc in August, 1929, and has been proceeding without interruption until the completion of the present figure which passed the tests of experts on November 10-15, 1931.

Meanwhile progress had gone on with the construction of the Observatory and the telescope mounting. The mounting for the telescope was designed and executed by the Warner and Swasey Company, of Cleveland. Temporary use of the mounting was assured through the loan of a 60-inch mirror belonging to the Harvard Observatory. When the decision was reached that the final mirror could be 69 inches in diameter, the mounting for the 61-inch mirror had already been in place in the Observatory for some months. An unanticipated task therefore presented itself of altering the mounting to accommodate the extra size in the mirror brought about through uncontrolled circumstances.

After careful analysis of the mechanical problems involved and in consultation with experts in telescope designing over the country, it was decided that the simplest and most satisfactory modification in the end would be to replace the structural tube of the telescope mounting with a new tube of sufficient proportions to accommodate the new mirror then definitely known to be 69 inches in diameter when finished. The plans ultimately adopted in consultation with the designers of the largest telescopes called for a tube to be built entirely of structural steel, and welded throughout by the new Lincoln process. By this method, manufactured stock, properties of which were definitely known, replaced heavy and expensive castings of uncertain strength with the result that the new tube with the enlarged mirror weighs almost exactly the same as the old tube with the smaller mirror, but has proportionately greater rigidity. The heavier and larger parts of the construction work of the new tube were manufactured by the Warner and Swasey Company, of Cleveland, to whom great credit is due for their interest and care in seeing that the most satisfactory design should be executed to the last detail.

The reconstruction of the tube gave opportunity for several improvements in the design and operation. The secondary mirrors at the upper end of the tube, which could be interchanged on the earlier model only with considerable difficulty, can now be changed with great ease by reason of a new type of container which was designed to make possible the interchange of the mirrors through the end of the tube when the latter is placed in a horizontal position.

Provision is made for using the telescope both as a Newtonian and a Cassegrainian instrument. In the Newtonian form the observer operates from the elevating platform attached to the inside of the dome. This position is to be used chiefly for direct photography of objects when the highest

magnification is not desired. When the Cassegrainian mirror replaces the Newtonian flat, starlight which is reflected upward from the large 69-inch concave surface is turned back again towards the lower end of the telescope, passing through a central hole in the large mirror 9 inches in diameter, to the eye-piece or to the photographic plate. In this latter arrangement the magnifying power is increased nearly five times, as the equivalent focus of this combination is 120 feet as compared with 25 feet for the Newtonian focus. The Casegrainian combination is the one more conveniently used for visual observations and for certain types of spectroscopic work. The focusing of the telescope in this form is effected by an electric motor at the upper end of the tube. An additional motor in the lower part of the tube automatically opens and closes the protecting shutters over the huge mirror at the press of a button.

Photographic attachments, guiding devices, plate holders, and photometric apparatus for measuring the plates taken through the telescope are being constructed in the instrument shop of the Observatory, which has been made possible through the generosity of friends interested in the development of the Observatory's programme. In this way a very considerable saving has been made possible in acquiring the necessary accessories to put the telescope into effective operation.

The completion of the 69-inch telescope brings to a realization a magnificent instrument for astronomical research, the possibility of which it is confidently believed will bring the contributions to science which Professor Perkins' untiring devotion and generous gift to Ohio Wesleyan merit. In addition to its principal uses as a research instrument in contributing to man's knowledge of the mysterious universe, it will be periodically open to the public and will form one of the most valuable pieces of equipment for advanced instruction in astronomical science.

THE EXTENDED COLLINSIC OF MIRABILITE.

Na_2SO_4, $10H_2O$.

by HAWKSWORTH COLLINS, B.A.Camb.

TABLE L

S.G.	**Theor.**		**15°C**		**1·493**				
S.G.	Obs.		20°C	Pettersson	1·492				
				Na_2	S	O_2	O_2	$6H'_2O$	$4H_2O$
O.R.	**85·205**	=	**0·3952**	**(11·865$_2$ +**	**15·53 +**	**7·53$_2$ +**	**2·51$_2$ +**	**14·03$_6$ +**	**18·02$_4$)**
R.I.	**Theor.**		**1·3952**						
R.I.	Obs.		1·394 to 1·398						
O.R.	**85·200**	=		**3·865$_2$ +**	**5·75 +**	**1·654$_2$ +**	**1·346$_2$ +**	**6·572$_6$ +**	**6·572$_4$**
H.F.	of			Na_2	SO_2		O_2	$6H'_2O$	$4H_2O$
	277034	=		**32747$_2$ +**	**O +**		**96155$_2$ +**	**3205$_6$ +**	**O**
	276730 obs.								
H.F.	gas 18°C		of		S	O_2			
	70899	=			**6217 +**	**32341$_2$**			
	71080 T								

H.F.	of	Na_2		S		O_2		O_2
	328703 =	**32747_2**	+	**6217**	+	**32341_2**	+	**96155_2**
	328100 T							
	328500							
H.F.	of	Na_2		SO_2		O_2		
	257804 =	**32747_2**	+	**O**	+	**96155_2**		
	257510 obs.							
	257970 aq.							

TABLE LI

H.F.	liq.	of		S		O_3					
	103240		=	**6217**	+	**32341_3**					
	103240	T									
H.F.	aq.	of				S		O		O_2	
	142414		=			**6217**	+	**71515**	+	**32341_2**	
	142410	T									
H.F.	aq.	of		Na_2		SO_3		O			
	186289		=	**32747_2**	+	**(96155 − 71515)**	+	**96155**			
	186643	obs.									

Specific Gravity of Sulphur

Crystallized Sulphur	32	÷	15·53	=	**2·0605 (Theor.)**
					2·063 Deville
					2·05 Karsten
Amorphous Sulphur	33	÷	17·15	=	**1·866 (Theor.)**
					1·87 Muller

The Law of Heat of Formation

H.F.		Const.		C.V.		At. Wt.	R.V.		C.V.		O.V.
6217	=	**120**	×	**1·62**	×	**32**	**15·53**	+	**1·62**	=	**17.15**
32341	=	**795**	×	**2·54**	×	**16**	**7·53**	+	**2·54**	=	**10·07**
71515	=	**795**	×	**5·62**	×	**16**	**4·45**	+	**5·62**	=	**10·07**
96155	=	**795**	×	**7·56**	×	**16**	**2·51**	+	**7·56**	=	**10·07**

Notes on Tables L and LI.

The Collinsic of Mirabilite is the 298th published in the *Chemical News.* The first portion on optical refractivity shows that four of the ten molecules of H_2O in the crystal are liquid water, the remaining six being crystallised water. H'_2O denotes the latter.

In the 298 collinsics,

the voloptic	11.685,	3.865 of Na	has now appeared	74 times
,,	15.53,	5.75 of S	,,	47 ,,
,,	7.53,	1.654 of O	,,	378 ,,
,,	2.51,	1.346 of O	,,	2113 ,,
,,	14.03,	6.572 of Aq.	,,	100's of ,,

The O.R. of liquid water appears here for the first time, being the same as that of cryst. H_2O.

In the last H.F. of Table LI the figures in the brackets mean that one atom of oxygen in the preceding H.F. has descended in volume from 4.45 to 2.51, thereby emitting 96155—71515 calories, so that the substance becomes

R.V. $11.865_2 + 15.53 + 7.53_2 + 2.51_2$
H.F. $32747_2 + 6217 + 32341_2 + 96155_2$
which is identical with mirabilite minus 10 H_2O.

The first line of the law of heat of formation shows that, if amorphous sulphur of relative volume 17.15 be caused to combine with oxygen, it loses 1.62 becoming 15.53, thereby emitting 6,217 calories.

The present paper shows the three forms of oxygen in as accurate a manner as anything was ever demonstrated. The same were frequently shown to be exactly true in the *Chemical News* during the years 1924-1928 when the structure of the elements was under consideration.

The first and second lines of H.F. in Table LI demonstrate that when liquid SO_3 is dissolved in water, only one of the four atoms is altered, and therefore the whole of the heat evolved is due to that one atom.

Many other remarks might be considered necessary, but they would only be repetitions from former papers, and so cannot be allowed. The abbreviations were explained in the last paper, C.N., 1932, CXLIV, 214.

In the last part of Table LI the constant for Na is 120; and this is also the constant for all elements of greater atomic weight than 23 (C.N. 1926, CXXXIII, 265). 795 is the constant for all elements of less at. wt. than Na, except H, of which the constant is 3196. So that the intrinsic energy of unit mass of all elements of greater at. wt. than 22 is to the intrinsic energy of unit mass of all elements of at. wt. less than 22, except hydrogen, as 120 : 795. And the intrinsic energy of H itself is proportionately 3196 (C.N. 1925, CXXXI, 35).

The name Mirabilite is singularly suitable to this salt, as it is the only mineral of the 298 which contains liquid water.

When liq. H_2O becomes cryst. H_2O, 3205 calories are always emitted. This was frequently explained in the years 1924-1928.

The S.G. of liquid water at 15° C. is 0.9987, and

$$\frac{18}{0.9987} = 18.02 \text{ (R.V.)}$$

The interdependence of all these figures demonstrate without any doubt whatever that the correct interpretation of each experimental datum has been obtained.

WORKS AND HOUSEHOLD REFUSE.

Efficient Utilisation for Steam Generation.

By a Well Known Engineer.

In chemical works, and the industrial establishment in general, an appreciable saving in running costs can generally be made by utilising all the refuse on scientific lines for steam and power generation. There almost invariably accumulates in such cases an astonishing collection of material such as paper, string, cardboard, broken boxes, tea leaves, and general kitchen refuse, old sacks, ashes and cinders, and general sweepings. Many industries, of course, have also a large output of combustible waste products from the processes, such as fruit seeds and skins, nutshells, and the residues from the extractions of alkaloids, and other products, of which dyestuffs, perfumes, spices, and tannins are examples.

It is necessary to handle all this refuse on scientific lines for three reasons, cleanliness and general well-being of the establishment, avoidance of fire risks, and effective utilisation of the heat content. The proper method is to burn the whole output for steam generation or other useful purpose, such as the production of steam or hot water. Most power users do not realise the amount and the heating value of the material which is also generally burnt in the boilers along with the coal under such conditions that efficient results are impossible.

In general such refuse has a nett heating value of at least 2,000-2,500 B.Th.U. per lb. and will evaporate 1-1½ lbs. of water to steam per 1 lb. of material, say one-fifth the value of good grade coal. Complete

combustion with full utilisation of the heat can however only be given by using forced draught so as to maintain the necessary very high temperature in the furnace. For this purpose the "Turbine" forced draught steam jet furnace is suitable, since it will burn works and household refuse as easily as any of the other many different fuels being utilised, from high grade coal and coke down to sawdust, peat, lignite, tan yard refuse, and general wet vegetable products. The arrangement of hollow trough firebars and a forced blast of air and steam results in an intense "local" heat almost a blow pipe action, while the bars are not affected because of the cooling and protecting action of the steam. As to whether it is better to use the refuse direct in the steam boilers equipped with forced draught on these lines, taking not over 3 per cent. of the steam produced, or to have a separate small combined destructor with an independent boiler for steam or hot water depends on the individual conditions.

One is glad to note also attention is now at last being given to the question of utilising household refuse for steam and power generation. In this connection average household refuse such as collected in London for example to the extent of 1,750,000 tons per annum and practically all wasted, consists approximately, in the dry state, of 0.3 per cent. coal, 0.1 per cent. coke, 23.5 per cent. breeze and cinders, 47.0 per cent. ash, 9.8 per cent. dust and dirt, 13.5 per cent. paper, straw, and fibrous and vegetable material, 0.5 per cent. rags, 0.3 per cent. bones and offal, 0.5 per cent. bottles, 0.3 per cent. other glass, 1.5 per cent. crockery, 0.7 per cent. metals, and 2.0 per cent. other material.

VALUABLE DEPOSITS OF SALT IN MARITIME PROVINCES, CANADA.

It has long been believed that valuable deposits of salt occur in the strata of the Maritime Provinces. Its presence is suggested by numerous brine springs which have from time to time been analysed and even utilised for the preparation of salt. Only recently, however, has any attempt been made to investigate the real nature of these deposits or their distribution. In 1917 a search was made for salt at Malagash, Nova Scotia. Here strong brine had been secured from wells drilled for water and salt was discovered at a depth of 85 feet, and has been mined continuously since discovery.

Proof that the salt strata in the Maritimes are extensive and occur probably in more than one horizon in rocks of Carboniferous age has been furnished lately by wells drilled for petroleum, according to Dr. G. W. H. Norman of the Dominion Department of Mines, Ottawa, who was engaged in mapping areas in the Maritimes during the 1931 field season.

Two wells at Gautreau, New Brunswick, on the east side of the Petitcodiac river, opposite Hillsborough, have penetrated several hundred feet of salt. A well drilled for oil by The International Petroleum Company, near Nappan, Nova Scotia, also passed through several hundred feet of salt, many of the beds of which were pure white, coarsely crystalline, and virtually free from impurities. Traces of potash were found in the salt and it is possible that local concentrations may eventually be discovered. This well signally increased the available information regarding the potential value of the salt deposits of Cumberland basin, Nova Scotia.

Salt deposits are probably present in the Windsor and Antigonish districts of Nova Scotia and in Cape Breton Island, as brine springs are known to occur in these districts. A small thickness of salt is reported in a driller's log in the Windsor district. At the present time, however, data on which to base any estimate of the prospective value of the salt in these basins are lacking, although the rocks are of the same ages as those in which the salt at Gautreau and in the Cumberland basin is found.

From investigations already made it is quite clear that the salt resources of the Maritime Provinces are very large. The proximity of these to adequate supplies of coal and to the seaboard greatly enhances their ultimate value.

DECLINE IN U.S. PHOSPHATES OUTPUT.

Monthly statistics of the Bureau of Census, U.S. Department of Commerce, compiled from reports from 87 fertilizer manufacturers, operating 158 plants, show that the production of super-phosphates in January, 1932, was less than for December, 1931, although larger than for any month since May, 1931. The January production was placed at 215,019 short tons of bulk super-phosphate against 230,684 short tons in December, and 179,405 short tons in November, 1931. Production of base and mixed goods were 28,834 short tons in January, approximately the same as in December, and 31,068 short tons were received from other acidulators. (This latter total includes both bulk super-phosphate and base and mixed goods.)

Stocks of bulk super-phosphate reached 1,341,512 short tons in January, the largest total since February, 1931. Stocks of base and mixed goods in January totalled 625,214 short tons, the largest since March of last year.

BY-PRODUCT AMMONIUM SULPHATE IN UNITED KINGDOM.

The British Sulphate of Ammonia Federation as of June, 1931, consisted of 245 members. During the last two years 107 members of the Federation have ceased production. At a recent meeting of the South Metropolitan Gas Co., the president said: " It is an unfortunate happening that while we have brought up the quality of our sulphate of ammonia to a standard which is unexcelled by any other make, the substantial return once received from its manufacture has during the year dwindled to some £10,000, and at the present it is being carried on at a heavy loss. The case is an excellent one of what might be described as 'irrationalised rationalisation.' In the carbonisation of coal, whether in gas retorts or coke-ovens ammonia is an unavoidable product. But throughout the length and breadth of the land this fertilizer is being thrown away and expensive plants for its refinement abandoned because the synthetic plants were designed for a greater

CONFERENCE OF FAMILY ALLOWANCES.

A two-day Conference on Family Allowances is to take place in the London School of Economics on Friday and Saturday, April 29th and 30th. Sir William Beveridge will open the first session by an address on " Some Economic Aspects of the Family." Sir William has long been an advocate of Family Allowances, and it will be interesting to hear if he draws any fresh conclusions from the results of the " Family Life " enquiry which he has recently made in conjunction with the B.B.C. Among others taking part are Miss Eleanor Rathbone, M.P., Professor Julian Huxley, Dr. R. A. Fisher, F.R.S., Mr. H. N. Brailsford, Mrs. Mary Stocks, Professor Gilbert Murray, and Sir Felix Brunner, Bt.

A Session on " Family Allowances in Practice," when a French business man will describe the continental system of industrial pools, is of special significance in view of the recent laws passed by the French and Belgian Governments making the payment of Family Allowances compulsory on all employers. The Agent-General for New South Wales and a representative of the New Zealand Government will speak on the working of the State Schemes in their own countries.

Tickets for the Conference (price 1/-), and particulars of the Public Meeting on Friday evening, are obtainable from the Secretary, Family Endowment Society, 52, Romney Street, S.W. 1.

CANADIAN IMPORTS OF ALUMINIUM SULPHATE DECLINE.

During the Fiscal year ending March, 1931, Canada's imports of aluminium sulphate totalled 473,341 hundredweight (of 112 pounds) valued at $541,079. This represented a decline of 56,500 hundredweight and $76,600 from the corresponding period of the previous year but was above the three-year average of about $500,000 in 1927, 1928 and 1929. In the fiscal year 1931, 418,000 hundredweight came from the

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

April 21st, 1932.

The following papers were read:—

Induced Melanism in Lepidoptera. By H. W. McKenny Hughes. Communicated by Sir Daniel Hall, F.R.S.

In an attempt to induce melanism in Lepidoptera after the method indicated by Professor J. W. Heslop-Harrison and Dr. F. C. Garrett, females of the Geometrid moth *Selenia bilunaria,* Esper, were collected in three different areas in Southern and Eastern England, as far as possible away from industrial areas. Two generations were fed upon pure untreated hawthorn, after which four subsequent generations were fed upon hawthorn treated with lead and manganese salts respectively. Brother and sister matings were adopted throughout the experiment. Adequate control broods were kept, and in all 3,265 moths were reared. No melanic individuals appeared at any time, either in the control or treated broods, and therefore the attempt to induce melanism in *Selenia bilunaria* by this treatment has failed.

Investigations on Mediterranean Kala Azar, VI. By S. Adler and O. Theodor. Communicated by Sir Henry Dale, Sec. R.S.

Eleven out of 100 dogs examined in Malta between June and November were found to be naturally infected with Kala Azar.

Seborrhea and partial depilation are the most frequent signs of canine Kala Azar and were found in nine out of eleven cases.

The skin condition is due to infiltration of macrophages round hair follicles. Infected macrophages are found throughout all parts of the skin both in the areas of infiltration round the hair follicles and in normal dermis.

Skin infection may be present in dogs with a slight visceral infection.

Histologically the skin infection can be readily differentiated from that produced by *L. tropica.*

Sandflies, *P. perniciosus,* were infected with *Leishmania* by feeding on the unbroken skin of three dogs. The infection rates were 62.5 per cent., 65.4 per cent., and 32 per cent. respectively.

The Morphology and Cytology of Bacterium malvacearum, *E.F.S., II. Reproduction and Cell-fusion.* By R. H. Stoughton. Communicated by Sir John Russell, F.R.S.

Using a technique described in a previous paper new morphological forms have been observed in *Bacterium malvacearum.*

The production of coccoid bodies, their liberation, and subsequent germination to form apparently normal rods, is described.

The formation of densely-staining spherical bodies, apparently arising from the point of fusion of two cells, is described. These bodies are apparently liberated by the degeneration of the parent cell.

THE PHYSICAL SOCIETY.

April 15th.

The following papers were read:—

The measurement of reflection coefficients for radiation at oblique incidence. By H. E. Beckett, B.Sc., Building Research Station.

A method is described whereby the effect of obliquity of incidence upon the reflection coefficients of certain materials can be examined. The material is spread upon the metal receiver of a thermopile which, when exposed to radiation, yields an e.m.f. proportional to the absorption coefficient of the surface. Results obtained with black and white paints and with polished copper are discussed.

A new type of interference refractometer, by W. Ewart Williams, M.Sc., Lecturer in Physics, King's College, London.

The importance of accurate refractive-index measurements in relation to spectroscopy is emphasized and the various methods hitherto employed are compared. A new type of interferometer is described in which the beam from the central part of the collimator objective is divided and each half laterally displaced. After passing through the gas tubes, the

beams are again reunited so that the interference pattern at the focal plane of the telescope objective is similar to that from a two-plate transmission échelon. The brightness of the fringes is approximately twenty times greater than with the usual Rayleigh interferometer, so that the instrument can be combined with a spectrograph for dispersion measurements. A new method, based on Benoit's "fractional part" principle, is developed for this purpose.

A direct reading γ-ray electroscope, by L. G. GRIMMETT, B.Sc., *Assistant Physicist,* Westminster Hospital, London.

A dead-beat direct-reading γ-ray electroscope having a linear scale graduated in milligrams of radium is described. It is a combination of a special ionization chamber, Lindemann electrometer and high resistance, and allows the estimation, in less than three seconds, of the activity of small γ-ray sources of the order 1 mgm. Ra with an accuracy of ½ per cent. on a full-scale deflection.

THE OPTICAL SOCIETY.

April 14th.

The following papers were read.

A Photometric Eyepiece for Visual Quantitative Spectrum Analysis. By MR. F. TWYMAN, F.R.S.

A new type of eyepiece is described whereby a spectrum is split into halves, a selected line of the one spectrum being brought vertically above a selected line of the other spectrum. The intensity of the brighter line is then reduced by means of a neutral tint wedge until equality of the two intensities is obtained. The eyepiece is used in an analysis of some cadmium-lead alloys, an accuracy of some 11 per cent. of the content being obtained.

The C.I.E. Colorimetric Standards and their Use. By MR. T. SMITH, M.A., and MR. J. GUILD, A.R.C.S., F.R.A.S.

The new international standards, which define a standard observer, three standard illuminants, standard conditions of illuminating and viewing opaque specimens, a standard for evaluating the brightness factor of opaque specimens, and a standard trichromatic system for the expression of colour measurements, are stated and their origin explained. In addition to the numerical tables which are appended to the resolutions setting up these standards, there are given a table specifying the trichromatic co-ordinates for the standard observer of all spectral colours at wave-length intervals of 1 mu tables to facilitate the calculation of the standard co-ordinates and the brightness factor of a material illuminated by any one of the three standard illuminants from spectrophotometric measurements on the material, and a table giving the co-ordinates of some stimuli of special importance on the N.P.L. system, the standard system, and another system which occurs in the resolutions. Some new colorimetric terms are proposed, partly to avoid misinterpretation and partly to meet new needs. The theory of colour transformations, and points which arise in the application of the system and in the calibration of instruments are discussed.

THE SOCIETY OF PUBLIC ANALYSTS.

April 6th, 1932.

The following papers were read:—

The Estimation of Hormones. By K. CULHANE, B.Sc., A.I.C., and S. W. F. UNDERHILL, M.A., B.M., B.Ch.

The physiological tests for the active principles of the internal secretions are discussed, and a description is given of the methods used for the estimation of insulin, pituitary posterior lobe extract, and adrenaline. In each case the effects of variations in the sensitiveness of the different animals is reduced to a minimum by using fairly large groups of a uniform stock, and the results are compared with those obtained under controlled conditions with the international standard preparations issued by the Health Organisation of the League of Nations.

The Chemical Assay of Thyroid Gland. By G. MIDDLETON, B.Sc., A.I.C.

The sources of error in the determination of the iodine content of thyroid gland is discussed, and a method is recommended in which the material is ignited with sodium carbonate in a double crucible. A complete process, involving this method of ignition, is given for the assay of the "acid-soluble iodine."

The Water-Protein Ratio of Lean Meat, and its Bearing upon the Analysis of Sausages. By F. W. Jackson, B.Sc., A.I.C., and Osman Jones, F.I.C.

Data are given for the ratios of water to protein in samples of meat representative of the average quality used by the manufacturers of high-grade sausages. From these results the ratios applicable to meats of different kinds and to mixed meat are deduced, and it is shown that by the use of these ratios the proportion of meat in sausages may be determined with a close approximation to the amount actually present.

Nitrate in Cured Meats. By Osman Jones, F.I.C.

Analyses showing the amounts of nitrite in various samples of nitrate-cured meats show that the proportion may rise to as high as 960 parts per million when brine has been repeatedly used for curing. Experiments indicate that the only function of the nitrate is to impart a red colour to the meat by reduction to nitrite, and the results so far obtained indicate that it would be advantageous to replace nitrates in curing, by a very small amount of nitrite.

Notes on the Freezing Point of Milk. By H. C. Lockwood, B.Sc., A.I.C.

An apparatus and method for the determination of the freezing point of milk are described. The apparatus includes a device for avoiding parallax.

THE GEOLOGICAL SOCIETY OF LONDON.

March 23rd, 1932.

Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S., President, in the Chair.

The following communication was read:

The Rocks between the Carboniferous and Trias in the Birmingham District. By Prof. William S. Boulton, D.Sc., A.R.C.S., F.G.S.

The results obtained from a detailed study of the cores from deep borings at Windsor Street Gas Works in east Birmingham led the Author to re-investigate the rocks in the Midlands which link up the Carboniferous and Trias.

The succession at Windsor Street is continuous to a depth of over 1,000 feet, and includes the Bunter (with a basal breccia), the Nechells Breccia, and part of the Calcareous Conglomerate Group.

The content of the breccias and conglomerates was described, and a graph was given showing the percentage distribution of rock types at different depths. The heavy mineral residues of the associated sandstones have also been determined.

The upper part of the Breccia Group, consisting of a coarse quartzite breccia, was shown to be of Bunter age, while the Nechells Breccia proper, 350 feet thick, consists of 70 to 80 per cent. of Uriconian igneous rocks. The Bunter Breccia is separated from the Nechells Breccia by an abrupt lithological break, but without angular discordance. A similar, and perhaps stronger break, occurs at the base of the Nechells Breccia. A detailed examination of the cores of other borings shows that these features are maintained throughout an area of at least two square miles in eastern Birmingham.

All available data were collected, and a map was given showing the shape of the pre-Trias floor of the Birmingham district west of the Birmingham Fault.

Evidence was given to show that the Barr Beacon Beds underlying the Bunter Pebble Beds, and mapped by the Geological Survey as Hopwas Breccia, are of Bunter age, and with them were correlated the breccias at Tower Hill, near Hamstead, and also the more extensive beds of sandrock at the base of the Bunter of Cannock Chase.

The content of the breccias of Hopwas, Sutton Park, Warley, Northfield, and the

Lickey were dealt with and compared, and evidence was adduced to show that, though discontinuous deposits, they are of the same general age, and have all been derived from highlands to the immediate east and south, whose outcrops mainly consisted of Uriconian falsite- and andesite-tuffs and lavas, and basalts.

Stress was laid on the extensive and prolonged erosion which accompanied and followed the Hercynian earth-movements in the area; the known Clent Beds (upper Enville Beds) must represent a small fraction of the deposits of this age, most of which lie concealed under newer beds in the Midlands. The Clent Beds are probably of the same age as some of the beds in the North of England, classed as Permian, which post-date the main Hercynian folding.

THE CHEMICAL SOCIETY OF JAPAN.

A System of Qualitative Analysis, Radically New and Highly Efficient. SAICHIRO NAGAMI and TAKIO KATO.

An Improved Method for Eliminating Troubles from Arcing at the Gap between Platinum Needle and Mercury Surface of the Thermostat Regulator. By NOBUO MORIGUCHI.

The Differential Solution of Potassium Chloride into Its Aqueous Solutions and the Activity of Potassium Chloride in Its Concentrated Solutions. By FUSAICHI MURATA.

New Determination of Equilibrium of Thermal Dissociation of Calcium Carbonate by "Thermanobalance." By SETSURO TAMARU, KENGO SIOMI and MASAAKI ADATI.

Electro-endosimosis in Closed Vessel. SAKUJI KOMAGATA.

Notices of Books.

Chemische Technologie der Neuzeit. Edited by DR. OTTO DAMMER. Second revised and enlarged edition by the late PROF. FRANZ PETERS and PROF. H. GROSSMANN. Vol. II., Part I., pp. xvi + 876. Stuttgart: Ferdinand Enke. 1932. Price 75 marks.

Dr. Otto Dammer's *Modern Chemical Technology* belongs to the class of comprehensive monumental works such as Prof. Mellor's *Treatises on Inorganic Chemistry*, Prof. Newton Friend's *Textbooks of Inorganic Chemistry*, Prof. Hackh's *Dictionary* and Prof. Thorpe's *Dictionary of Applied Chemistry*. Volume 2 of *Chemische Technologie*, the first part of which lies before us, is concerned with (a) Metals and Alloys, (b) Surface Protection of Metals and (c) Preparing Ores for Treatment.

These are all wide subjects and all have attracted much attention in the last few decades, *i.e.*, in modern times. In order to cope with the researches and published work on metals, ores, alloys, etc., the authors have called in the help of a score of distinguished German specialists and with expert collaboration this thorough work of reference has been constructed. The late Prof. Peters did not live to see his long and able section on the pre-reduction treatment of ores appear in print and so much time has elapsed since this work was begun that five other collaborators have also passed away. The magnitude of the authors' task will perhaps be best appreciated when it is mentioned that no less than 300 periodicals are given among the references and they include not only such journals as *The Chemical News* but publications exclusively devoted to the technology of one metal or of one type of process.

In the section upon metals and alloys all the characteristics of the pure elements and their mixtures are fully discussed and much really valuable information has been collected together, probably for the first time.

The various effective means for combating rust and tarnishing, especially as practised on the continent, are explained in detail in the second part of this volume and the merits and drawbacks of certain processes are indicated. The third section, which will appeal especially to metallurgists, exhaustively covers the general works practise in connection with washing, grinding, grading, drying, etc., of ores before they are made to undergo the chemical treatment to yield up their metals. A feature of this comprehensive treatise is the number of illustrations (over 600). The complete work in five volumes will prove indispensable to all metallurgists and metallurgical chemists.

Volumetric Analysis, by G. FOWLES, M.SC., A.I.C., pp. xii + 202. G. Bell & Sons Ltd., York House, Portugal Street, London, W.C.2. 6s. net. N.B. Chapter one of this book is available separately under the title "Introduction to Volumetric Analysis." Price 1s. 4d.

Mr. Fowles, in this volume, has presented a concise handbook to students of Chemistry, chapter one being a sufficient course in preparation for the School Certificate Examination, the remaining chapters dealing with the more advanced study of the subject. The progress of science has not left volumetric analysis behind,

as the available literature now proves. Year by year new indicators are announced, fresh methods devised and new reactions employed. In this book, the author always has endeavoured to incorporate the best of the modern work, and whilst many of the traditional methods have either been omitted or given as alternatives, he has yet drawn copiously (with due acknowledgement) from such works as Hartley, Treadwell, Beckurts and Prideaux. For instance, in neutralization processes standard substances other than sodium carbonate and oxalic acid are recommended, and litmus is replaced by methyl red and other modern synthetic dyes. A feature throughout the hook and one of great discernment, is the very successful endeavour to present chemistry as a series of related phenomena rather than as a collection of isolated facts.

The theory of indicators receives considerable attention and a praiseworthy innovation is the introduction of the symbol PH at an early stage thereby simplifying several of the subsequent explanations.

A synopsis contained in the final chapter of the volumetric process for the estimation of all common metals, acid radicals and many organic compounds, makes the problem of extracting a working procedure from this information not beyond the capacity of the ordinary student, who has worked through the book.

The hook is completed by a table of atomic weights, unfortunately not up to date, Rhenium (75) being omitted and in several cases, the old values for several elements are shown, notwithstanding the fact that the values have been known for several years. I hope that this fault will be rectified when a new edition is called for.

H. W. B. R.

BRITISH TRADE WITH POLAND.

A meeting of the Committee for foreign trade policy, presided over by Mr. Okolski, held at the Warsaw Chamber of Commerce in order to discuss the result of the delegation's visit to the British Industries Fair, is reported by the *Gazeta Handlowa* of March 25. (Members of this delegation of the Chamber of Commerce were MM. Komorowski, Puzanski and Wartalski.)

After discussing the general character and line imposed on Poland's exchange of goods by the commercial policy of this country's near and far neighbours, the Committee agreed upon the necessity for importing goods from countries which do not hinder Polish export. Special attention was given to the question of substituting imports from countries with which Poland has no commercial treaties by goods of United Kingdom origin, particularly with regard to British machinery and metal industry goods, as well as to Colonial goods originating from British Colonies and imported into Poland via foreign ports.

The Committee agreed to take up concrete commercial relations with the United Kingdom, as proposed by the different speakers, and the representatives of the Polish Union of the Metal Industry declared themselves ready to fully realise this scheme, as far as they were concerned.

Finally, steps were agreed upon, aiming at the foundation of a Polish-English Chamber of Commerce at Warsaw and an English-Polish Chamber of Commerce in London, with the view of supporting the development of commercial relations between these two countries.

Notices.

DEUTSCHE BUNSEN GESELLSCHAFT.

General Meeting at Munster, 16-19 May.

The German Bunsen Society will hold its General Meeting at Munster i.W. on May 16th to 19th. Lord Rutherford and Prof. Otto Hahn are to be among those presenting papers to be read and discussed on the subject of Radioactivity. A comprehensive programme has been arranged.

BRITISH ASSOCIATION OF CHEMISTS.

London Section. The Annual General Meeting of the London Section will be held on Friday, 13th May, 1932, at 7 p.m. (instead of 6th May as previously notified), at the Broad Street Station Restaurant, London, E.C. This will be followed by a Smoking Concert at 8.15 p.m. and it is hoped that members will make a special effort to attend with their friends.

X-RAY CRYSTAL ANALYSIS AND ITS VARIOUS APPLICATIONS.

Exhibition at the Royal Institution.

The discourse to be given by Sir William Bragg at the Royal Institution Conversazione on Friday evening, May 6th, will be related to the various developments in pure and applied science which have depended on the use of the X-ray mthods of analysing crystal structure. In order to supplement the discourse, which cannot refer to more than a few of the more important points, an exhibition is being arranged in the rooms of the Royal Institution which will demonstrate more fully the work that has been done. The contributors will be those who have carried on research work in this subject in various British laboratories, so that the result should be interesting and, as far as space allows, comprehensive. As there may be many who, being interested in these developments, would like to see the display, the Managers of the Royal Institution would like it to be generally known that all members of scientific societies or senior students of universities and technical institutions, and others interested in this work will be welcome if they present themselves at the Royal Institution, 21, Albemarle Street, W. 1, at any time between 10 a.m. and 6 p.m. on Monday 9th

or Tuesday, May 10th. The Managers would be glad if such visitors would leave their names and addresses.

THE BRITISH SCIENCE GUILD.

A popular lecture on

"POLAR LIGHTS"

will be given by Professor Sydney Chapman, M.A., D.Sc., F.R.S., to members of the British Science Guild and others on Wednesday, 25th May, at 4.30 p.m.

The lecture will take place at the Royal Society of Arts, John Street, Adelphi, W.C. 2. Tickets, for which no charge is made, can be obtained on application to the Secretary, British Science Guild, 6, John Street, Adelphi, W.C. 2.

New Patents.

These particulars of New Patents of interest to readers have been selected from the Official Journal of Patents and are published by permission of the Controller of H.M. Stationery Office, and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, at the uniform price 1/- each.

Abstract Published.

Group Abridgments can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2., either sheet by sheet as issued on payment of a subscription of 5s. per Group Volume or in bound volumes price 2s. each.

364,201.—Ammonium salts, sulphur oxides, catalytic agents.—Gutehoff-Nungshutte Oberhausen, Akt.-Ges., Rhineland, Germany.

Gases containing ammonia and non-oxygenated sulphur compounds, such as hydrogen sulphide, are passed with oxygen or gases containing oxygen at a temperature up to 400° C. and at ordinary or raised pressure over a catalyst comprising an oxide of nickel and/or cobalt mixed with a substantial excess of a water-insoluble or difficultly soluble compound of calcium, barium, magnesium, and/or silicon. The ammonium salts so produced are separated hy cooling or in an electro-filter. Industrial gases such as coke-oven gases or distillation gases may be treated directly, or the ammonia may be washed out from the gases and then subjected to the treatment together with hydrogen sulphide obtained either from the gases or in any other way; for example, the hydrogen sulphide in the gases may be converted into iron sulphide and the latter then decomposed. According to the examples (1) a mixture of coke-oven gas with 10 per cent. of air is passed at 190° C over a mixture of gypsum with 2 per cent. of cobalt oxide; (2) a mixture of coke-oven gas with 9 per cent. of air is passed at 245° C. over a mixture of magnesium oxide with 4 per cent. of nickel oxide; examples are given also of the treatment of coke-oven gases in the presence of mixtures of lime with 2 per cent. of nickel oxide or with 1.5 per cent. of cobalt oxide.

The Specification as open to inspection under Sect. 91 (3) (a) refers to the conversion of non-oxygenated sulphur compounds, such as hydrogen sulphide, into sulphur oxides with the aid of the catalysts described above. This subject-matter does not appear in the Specification as accepted.

The Latest Trade Marks.

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of H.M. Stationery Office, and the Trade Marks Journal can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

SILBE.

526,228.—Chemical substances for use in the treatment of internal diseases of animals. —Dr. Ernest Silten, trading as Dr. Ernest Silten, Fabrik Chemisch-Pharmazeutischer Preparate, Karlstrasse 20a, Berlin, N.W. 6, Germany. April 6. (Associated.)

528,802.—Three fish and the words THREE FISHES BRAND.—Chemical substances used for agricultural and horticultural purposes. The Firm trading as The Kingston Chemical Company, 2a, Southsea Road, Kingston-on-Thames. April 6.

MAXIMAC.

529,116.—All goods in Class 2 which includes chemical substances used for agricultural, horticultural, veterinary and sanitary purposes, but not including phosphate fertilisers and not including any goods of a like kind to phosphate fertilisers. —Cooper, McDougall & Robertson Limited, Chemical Works, Ravens Lane, Berkhamsted, Hertfordshire. April 6. (Associated.)

NICTAGRAL.

529,947.—*Chemical substances used for agricultural*, horticultural, veterinary and sanitary purposes. British Dyestuffs Corporation Limited, Hexagon House, Blackley, Manchester. April 6.

THE CHEMICAL NEWS

General Offices: MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4. *Telephone*: Central 4960

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A THEORY OF THE RATE OF SOLUTION OF GAS INTO LIQUID

By SUSUMU MIYAMOTO

A theory of the rate of solution of gas into liquid, which has great probability not only for the interpretation of the phenomena already studied by many writers, but also for the interpretation of the rate of oxidation of sodium sulphite solution, was described in previous papers.[1] The object of the present paper is to discuss the new theory in comparison with theories advanced by other writers.

Noyes and Whitney[2] interpreted the rate of reaction at solid-liquid interfaces by the theory based upon the assumption that the process is composed of two stages, namely extremely rapid reaction in the interfacial layer and also slow diffusion of the reactants and resultants from the layer. Nernst[3] extended this diffusion theory and proposed that the reaction velocity in heterogeneous systems is universally composed of the two stages above indicated.

Adeney and Becker[4] had studied the rate of solution of air, oxygen and nitrogen from the surface of bubbles of known magnitude into water, and proposed the following equation to interpret the experimental results,

$$\frac{dw}{dt} = SAp - f\frac{S}{v}w, \quad \ldots\ldots\ldots\ldots\ldots(1)$$

where A is the initial rate of solution per unit area, f the coefficient of escape from the liquid per unit area and volume, S the area of the boundary surface, v the liquid volume, p the gas pressure and w the weight of gas dissolved.

(1) S. Miyamoto and T. Kaya, The Bulletin of the Chemical Society of Japan, *5* (1930), 132; S. Miyamoto and A. Nakata, ibid., *6* (1931), 18; S. Miyamoto, T. Kaya and A. Nakata, ibid., *6* (1931), 140.

(2) Z. physik. Chem. *23* (1897), 689.

(3) Ibid., *47* (1904), 52.

(4) Phil. Mag., *38* (1919), 317; *39* (1920), 385; *42* (1921), 87.

Donnan and Masson[1] modified the equation of Adeney and Becker, and proposed the following equations.

$$\frac{dw}{dt} = k_2[kc_g - c_1], \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

when the system obeys Henry's law, and

$$\frac{dw}{dt} = k_2\left[f(c_g) - c_1\right], \quad \ldots\ldots\ldots\ldots\ldots(2')$$

when Henry's law does not hold.

In these equations, c_g is the concentration of absorbable gas in the gas phase, c_1 the corresponding concentration in the liquid phase, k the Henry's law coefficient, and k_2 a constant.

The above mentioned equations may be expressed by a slight rearrangement in the form,

$$\frac{dw}{dt} = k(c\infty - c_1), \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

where $c\infty$ is the concentration of saturated solution, and k a constant.

For the rate of solution of gas into liquid, the following expression was proposed by Lewis, Whitman and Keats[2],

$$\frac{dw}{dt} = k_p(p_g - p_1), \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

where p_g and p_1 are the partial pressures of the absorbable component in the gas phase and in the liquid phase respectively.

Whitman and Keats[3] assumed the existence of a stationary gas film and a stationary liquid film at the boundary surface and proposed the following equation for the rate of absorption.

$$\frac{dw}{dt} = k_p(p_1 - p_2) = k_c(c_2 - c_3), \quad \ldots\ldots(5)$$

where $p_1 - p_2$ is the partial pressure gradient of the solute in the gas film, and $c_2 - c_3$ is a concentration gradient in the liquid film, k_p and k_c being constants.

Davis and Crandall [4] assumed that the upper surface of the liquid film is almost instantaneously saturated with the gas, and interpreted the results of their research on the rate of solution of oxygen into water by the equation,

$$\frac{1}{S}\left(\frac{dn}{dt}\right) = k_1(c\infty - c_1), \quad \ldots\ldots\ldots\ldots\ldots\ldots(6)$$

where $c\infty$ is the saturation concentration of the dissolved gas, c_1 the concentration of the gas in the liquid phase, k_1 a constant, n the number of moles of the gas in the liquid phase, and S the area of the boundary surface.

The theories of Davis and Crandall is similar to that of Nernst, Noyes and Whitney, and equation (6) is equivalent to equation (3).

When the gas reacts with a component in the liquid phase, the rate of absorption of the gas would depend upon the concentration of the solute. Davis and Crandall[5] proposed the following equation for the rate of solution when the reaction velocity is very great,

$$\frac{1}{S}\left(\frac{dn}{dt}\right)_{\text{Initial.}} = k_1(c\infty + c_m), \quad \ldots\ldots\ldots\ldots\ldots(6')$$

where c_m is the concentration of the reacting solution in the main body.

A New Theory of the Rate of Solution of Gas into Liquid.

The above mentioned theories are based upon two assumptions; the existence of a stationary film of liquid or stationary films of liquid and gas, and the instantaneous saturation of the upper layer of the stationary film with the gas.

These assumptions will not be satisfied in certain cases, as will be discussed later. The existence of a stationary film of such thickness as the diffusion theory requires will be questionable when the main body of the liquid is well agitated with a proper stirrer, and as the present writer has previously shown,[6] the assumption of the instantaneous saturation of the upper layer of the liquid with gas cannot be adopted to interpret the rate of oxidation of sodium sulphite solution.

The theory of the present writer[7] is based upon quite different assumptions, hereinafter described.

(1) J. Soc. Chem. Ind., *39* (1920), 236.
(2) Lewis, J. Ind. Eng. Chem., *8* (1916. 825; Whitman and Keats, Ibid., *14* (1922), 185.
(3) Ibid.
(4) J. Am. Chem. Soc., *52* (1930), 3757.
(5) Ibid., *52* (1930), 3769.
(6) Miyamoto, Kaya and Nakata, Bull. Chem. Soc. Japan, *6* (1931), 134.
(7) The theory, described in the previous papers, loc. cit., was slightly revised.

The process of solution of gas into liquid can be separated into two processes, namely the penetration of gas molecules into the liquid phase, and the escape of the gas molecules from the liquid phase. Then the rate of solution of gas into liquid can generally be expressed by

$$\frac{N}{S}\left(\frac{dn}{dt}\right) = N'' - N''' \text{ .... (7)}$$

when n is the number of moles of the absorbable gas N Avogadro's constant, N'' the number of molecules of gas which enter into the liquid phase per unit area of the interface per unit of time, N''' the number of molecules of gas which escape from the liquid phase per unit area per unit of time, and S the area of the boundary surface.

According to the kinetic theory of gases, the value N'' should be a fraction of the number of molecules which collide with the unit area of the interface per unit of time, N', then,

$$N'' = \beta N', \text{ .... (8)}$$

where β represents the ratio of the number of molecules which penetrate into the liquid phase and the number of molecules which collide with the liquid phase, N' being the number of molecules which collide with the unit area of the boundary surface per unit of time.

By Maxwell's distribution law of velocities,

$$dN = \frac{N}{\sqrt{\pi}a} e^{-\frac{u^2}{a^2}} du, \text{ .... (9)}$$

where dN signifies the number of molecules whose components of velocities at right angles to a fixed plane lie between u and $u + du$ among N molecules, and

$$a^2 = \frac{2RT}{M}, \text{ .... (10)}$$

where R is the gas constant, T the absolute temperature, and M the molar weight of the gas.

It is then easily seen that the value N' can be expressed by

$$N' = \int_0^\infty \frac{N}{V\sqrt{\pi}a} u e^{-\frac{u^2}{a^2}} du = \frac{Np}{\sqrt{2\pi MRT}}, \text{ .... (11)}$$

where V is the molar volume of the gas, N Avogadro's constant, p the partial of pressure of the gas, $\frac{N}{V}$ being the numbers of molecules per unit volume of gas.

Now an assumption is proposed. Among the molecules, which collide with the liquid surface, only those whose components of velocities at right angles to the interface are greater than a threshold value u_0, are able to enter into the liquid phase.

Then the value N'' will be expressed by

$$N'' = \int_{u_0}^\infty \frac{N}{V\sqrt{\pi}a} u e^{-\frac{u^2}{a^2}} du = \frac{Np}{\sqrt{2\pi MRT}} e^{-\frac{Mu_0^2}{2RT}} \text{ .... (12)}$$

From (6), (11) and (12) it is seen that

$$\beta = e^{-\frac{Mu_0^2}{2RT}} \text{ .... (13)}$$

From the similar assumption, that among the molecules of gas in the liquid phase, only those, which collide with the interface with velocities whose components at right angles to the boundary surface are greater than a threshold value u_0', are able to escape from the liquid phase, we can obtain the value N''' according Maxwell's distribution law.

$$N''' = \int_{u'_0}^\infty \frac{c_1 N}{1000} \frac{1}{\sqrt{\pi}a} u e^{-\frac{u^2}{a^2}} du = \frac{c_1 N}{1000} \sqrt{\frac{RT}{2\pi M}} e^{-\frac{Mu_0'^2}{2RT}}, \text{ .... (14)}$$

where c_1 is the concentration of the gas in the liquid phase, N Avogadro's constant, $\frac{c_1 N}{1000}$ being the number of molecules of the gas per unit volume of the liquid. The concentration of the gas in the liquid phase will depend upon the depth of the liquid, and, strictly speaking, the mean value of the concentrations of the effective region should be used for the value c_1, but when the main body of the liquid is stirred, the concentration of the main body may be employed as a first approximation.

From the equations (7), (12) and (14) we have

$$\frac{N}{S}\frac{dn}{dt} = \frac{Np}{\sqrt{2\pi MRT}}e^{-\frac{Mu_0^2}{2RT}} - \frac{c_1 N}{1000}\sqrt{\frac{RT}{2\pi M}}e^{-\frac{Mu_0'^2}{2RT}},$$

or

$$\frac{dn}{dt} = \frac{p}{\sqrt{2\pi MRT}}Se^{-\frac{Mu_0^2}{2RT}} - \frac{c_1}{1000}S\sqrt{\frac{RT}{2\pi M}}e^{-\frac{Mu_0'^2}{2RT}} \quad \ldots\ldots(15)$$

This is the general equation for the rate of solution of gas into liquid, obtained from the new theory. The values of u_0 and u'_0 will depend upon the nature of gas and liquid.

The initial rate of solution, or the rate of solution of gas when the liquid is perfectly free from the gas, can be obtained from the above equation by putting $c_1 = 0$,

$$\left(\frac{dn}{dt}\right)_{\text{Initial}} = \frac{p}{\sqrt{2\pi MRT}}Se^{-\frac{Mu_0^2}{2RT}} \quad \ldots(16)$$

When the liquid is saturated with the gas,

$$\frac{dn}{dt} = 0.$$

Then in the state of saturation,

$$\frac{p}{\sqrt{2\pi MRT}}Se^{-\frac{Mu_0^2}{2RT}} = \frac{c\infty}{1000}S\sqrt{\frac{RT}{2\pi M}}e^{-\frac{Mu_0'^2}{2RT}}, \quad \ldots\ldots(17)$$

where $c\infty$ is the concentration of the saturated solution.

Then the equation (15) can be expressed in the form

$$\frac{dn}{dt} = KS(C\infty - C_1), \quad \ldots\ldots(18)$$

where

$$K = \frac{1}{1000}\sqrt{\frac{RT}{2\pi M}}e^{-\frac{Mu_0'^2}{2RT}} \quad \ldots\ldots(19)$$

Equation (18) is exactly equivalent to equation (3). Thus equation (3), experimentally obtained and theoretically explained by the old theories, has also been derived from the new theory.

The equations (15), (16) and (18) were derived without the assumption of the existence of stationary boundary films, and these equations will also be satisfied when the main body of the liquid phase is quiescent and the existence of a stationary liquid film is taken into consideration.

In this case,

$$n = n_1 + n_2 \quad \ldots\ldots(20)$$

where n is the total number of moles of the absorbed gas in the liquid phase, and n_1 and n_2 the number of moles of the gas in the stationary liquid film and in the main body respectively.

$$\frac{dn}{dt} = \frac{dn_1}{dt} + \frac{dn_2}{dt}. \quad \ldots\ldots(21)$$

Now,

$$\frac{N}{S}\frac{dn_1}{dt} = xN'' - yN''' - K(c_s - c_1) \quad (22)$$

where xN'' is the fraction of gas molecules which enter into the liquid phase per unit of area per unit of time, yN''' the fraction of gas molecules which escape from the

liquid phase per unit of area per unit of time, $K(c_s-c_1)$ the number of molecules of gas which enter into the main body from the stationary film by diffusion, c_s the concentration of gas at the upper surface of the film, c_1 the concentration in the main body, N Avogadro's constant, S the area of the boundary surface, and x and y constants less than 1.

$$\frac{N}{S}\frac{dn_2}{dt} = (1-x)N'' - (1-y)N''' + KS(c_s-c_1). \quad \ldots\ldots(23)$$

From the equations (21), (22) and (23),

$$\frac{N}{S}\frac{dn}{dt} = N'' - N''' \quad \ldots\ldots(24)$$

From the equations (12), (14) and (24) we have

$$\frac{dn}{dt} = \frac{p}{\sqrt{2\pi MRT}} S e^{-\frac{Mu_0^2}{2RT}} - \frac{cS}{1000}\sqrt{\frac{RT}{2\pi M}}\, e^{-\frac{Mu_0'^2}{2RT}}, \quad \ldots\ldots(25)$$

which is equivalent to equation (15), and by a slight rearrangement,

$$\frac{dn}{dt} = KS(c\infty - c), \quad \ldots\ldots(26)$$

which is equation (18).

In the equations (25) and (26) the mean value of concentrations of the effective region should be employed for the value c.

Discussion.

The rate of oxidation of sodium sulphite solution and the effect of many substances on the velocity have been investigated by many writers.[1]

The present writer has also studied the rate of oxidation of the same substance under special conditions, and the assumption, that the rate of oxidation obtained by the present writer is equivalent to the rate of solution of oxygen into water, free from oxygen, was proposed from the following reasons.

(1) The rate of oxidation of sodium sulphite solution, obtained, is the maximum value, which does not increase further with the increase of concentration of sodium sulphite. It was also found that this maximum value is not a specific value of sodium sulphite solution. The maximum velocities of oxidation of sodium sulphite, stannous hydroxide and ferrous hydroxide are identical under the same conditions[2].

(2) The rate of oxidation of sodium sulphite solution does not increase above this maximum value with the further increase of concentration of sodium sulphite, on the contrary it decreases when the concentration is very great[3].

(3) The total quantity of sodium sulphite, stannous hydroxide and ferrous hydroxide oxidized during a definite time interval in the same vessel is not greater than when they are oxidized separately. The rate of absorption of oxygen by the solution does not increase by mixing these oxidizable compounds[4].

(4) The maximum rate of oxidation of sodium sulphite solution is proportional to the area of the interface of the solution[5]. It was also confirmed that this maximum value is proportional to the partial pressure of oxygen[6].

(5) As was mentioned in the previous paper[7], the rate of solution of oxygen, calculated from the maximum rate of oxidation of sodium sulphite solution, has nearly the same value as the initial rate of solution

(1) Bigelow, Z. physik. Chem, *26* (1898), 493, Titoff, Z. physik. Chem., *45* (1903), 641, Bäckstrom, J. Am. Chem. Soc., *49* (1927), 1465, Alyea and Bäckstrom, J. Am. Chem. Soc., *51* (1929), 90. Blood Ryan. *Research Bull* 2. Fac. Scs. (1932).

(2) Miyamoto, Bull. Chem. Soc. Japan, *2* (1927), 74; *2* (1927), 155; *3* (1928), 98; *3* (1928), 137.

(3) Miyamoto and Kaya, Bull, Chem. Soc. Japan, *6* (1931), 270.

(4) Miyamoto, ibid., *2* (1927), 192; *4* (1929), 132.

(5) Miyamoto and Nakata, ibid., *6* (1931), 9.

(6) Miyamoto, Kaya and Nakata, ibid., *5* (1930), 229.

(7) Miyamoto and Nakata, ibid., *6* (1931), 22.

of oxygen into water, observed directly by several writers.

From these reasons, it follows that the maximum rate of oxidation of sodium sulphite solution is equivalent to the rate of solution of oxygen into water, free from oxygen, which is given by equation (16), according to the theory of the present writer. From equation (16), the value u_0 was calculated[1], using the observed maximum rate of oxidation of sodium sulphite solution, and it was found that the value u_0 is 1.65×10^5 cm./sec., approximately 3.4 times the root-mean-square velocity of oxygen gas, and is independent of temperature in the range 15°—35° C.

The diffusion theory assumes the existence of a stationary film at the interface. According to the new theory the equation (3) has been obtained both when the existence of a stationary film was assumed and when it was rejected.

When the liquid phase is quiescent, the existence of a stationary liquid film has great probability, but when the liquid phase is well stirred, the assumption that a stationary liquid film of such thickness as that, calculated by Brunner[2] and Crandall[3] from the diffusion theory (2×10^{-2}—2×10^{-3} cm.), exists at the interface, can not be accepted without direct confirmation.

As a result of the study on the oxidation velocity of sodium sulphite solution by oxygen in the presence of a molecular film of fatty acid[4], it was ascertained that when the main body of the sodium sulphite solution is well agitated, the thickness of the stationary film, if it exist, should be less than the length of a molecule of palmitic acid (23.7×10^{-8} cm.).

It will be difficult to interpret the result of the present writer's measurement of the oxidation velocity of sodium sulphite solution by the diffusion theory, which requires the existence of a stationary film whose thickness is about 10^4 times the value determined experimentally[5]. The fact that the rate of oxidation of sodium sulphite solution is independent of the concentration of sodium sulphite in the range of about 0.3—0.7 normal, will also be difficult to interpret by the diffusion theory, according to which the interface is instantaneously saturated with gas. The equation (6′)

$$\frac{1}{S}\left(\frac{dn}{dt}\right)_{\text{Initial}} = k_1(c_\infty + c_m),$$

which is based upon the assumption that the upper layer of the surface film is almost instantaneously saturated with gas, does not hold in the case of the oxidation of sodium sulphite solution. The oxidation velocity is independent of the concentration in the range above described; it depends upon the concentration only when the concentration is very small or very great. According to the theory of the present writer, the rate of oxidation of sodium sulphite solution is less than the initial rate of sodium of oxygen into water when the concentration of sodium sulphite is very small, and the rate of oxidation is greater than the initial rate of solution of oxygen into water when the concentration of sodium sulphite solution is in the range of 0.3—0.7 normal. In the former case, the rate of oxidation depends upon the concentration of sodium sulphite solution, and in the latter case, the rate of oxidation is equivalent to the initial rate of solution of oxygen into water, free from oxygen, which is expressed by equation (16), and is independent of the concentration of sodium sulphite solution.

The rate of solution of oxygen into sodium sulphite solution decreases when the concentration of sodium sulphite solution is very great,[5] as was above mentioned. This fact will be endorsed by the equation (6′), which is based upon the diffusion theory, if the decrease of solubility of gas c_∞ be taken into consideration, but the diffusion theory is not satisfactory for the interpretation of the initial stage of the rate of oxidation of sodium sulphite solution, as was above pointed out. According to the new theory the rate of oxidation of concentrated sodium sulphite solution is easily explained by the consideration that in this stage the rate of oxidation is also equivalent to the rate of solution of oxygen into the solution, free

(1) Miyamoto and Nakata, Bull. Chem. Soc. Japan, *6* (1931), 270.
(2) Z. physik. Chem. *47* (1904), 99.
(3) J. Am. Chem. Soc., *52* (1930), 3760.
(4) Miyamoto, Kaya and Nakata, Bull. Chem. Soc. Japan, *6* (1931), 133.
(5) Loc. cit.

from oxygen, which is expressed by equation (16), but the value u_0, which depends upon the nature of the liquid phase, increases with the increase of the concentration of sodium sulphite solution.

The coincidence of the velocities of oxidation (by air) of sodium sulphite, stannous hydroxide and ferrous hydroxide in sodium hydroxide solution[1] under the same conditions is another experimental fact favourable for the theory of the present writer.

The maximum oxidation velocity of sodium sulphite solution is proportional to the partial pressure of oxygen, as the new theory requires. The maximum oxidation velocity is equivalent to the value, given in equation (16).

In conclusion it may be said that the new theory interprets not only the experimental facts which are explained by the diffusion theory, but also those, which will be difficult to interpret by the old theory.

The new theory acquires greater probability in so far as it does not assume the existence of a stationary liquid film at the interface. The existence of a stationary liquid film of such thickness as that calculated by the diffusion theory is questionable, when the main body of the liquid is well agitated with a stirrer.

Summary.

(1) A theory of the rate of solution of gas into liquid has been proposed, which is based upon the assumptions, (a) that among the molecules of gas, which collide with the interface, only those, whose components of velocities at right angles to the interface are greater than a threshold value u_0, can enter into the liquid phase, and (b) that among the molecules of gas in the liquid phase, only those, which collide with the interface with velocities, whose components at right angles to the interface are greater than a threshold value u'_0, can escape from the liquid phase.

(2) A short discussion of the theory in comparison with the older theories has been put forward.

(3) The rate of oxidation of sodium sulphite solution, which is difficult to interpret by the diffusion theory has been interpreted by the new theory.

[1] Loc. cit.

Laboratory of Physical Chemistry, Hiroshima University, Hiroshima, Japan.

MATTER AND LOGIC.

The Explanation of the Michelson-Morley-Miller Experiment in Connection with Our Present-Day Knowledge of Light.

By Dr. W. Tombrock.

As this experiment is based on an interference phenomenon and on the undulation theory, a definite (positive) effect is to be expected from it. This effect, however, was not observed. It is now almost generally accepted that the effect is null (negative).

In order to explain this disappointing and unexpected result and yet maintain the old views as a basis, the auxiliary hypotheses of the Fitz-Gerald, Lorentz contraction of the apparatus and later (really as an improvement on this) the Special Theory of Relativity were conceived.

In the meantime our views about the nature of light have changed. We now suppose that light must be undulation and emission, thus both and not the one or the other.

Can these new views perhaps explain the famous experiment in a direct, unforced manner, without resort to the above mentioned auxiliary hypotheses? Yes.

First of all the observed interference bands show that undulation is really playing a part in the experiment. But the null-effect obtained points not to undulation but to emission. The null-effect means that the motion of the apparatus (of the earth) exerts no influence on the interference phenomenon. In other words the light behaves as if the apparatus did not move but remained at rest, that is to say the light shares in the motion of the apparatus. This means that the photons share in the velocity of the light source.

This explanation exhibits immediately the connection between emission and undulation in the present case. This connection must be a caucal one and the emission thereby becomes the primary quality. The emission is dominant in the propagation of light, and hence the null-effect is produced. It is only first in the interference at a definite point that the

undulation makes its appearance, and so is thus controlled by the emission.

We thus see that present-day knowledge of light puts us in a position to explain the Michelson experiment, its interference bands and its null-effect *without* auxiliary hypotheses, without contraction and without the Special Theory of Relativity.

In connection with this it may be pointed out that this explanation at the same time affords support for the atomic hypothesis which I have developed. ("The Chemical Atom" in *The Chemical News*, 1930-31). In this the velocity of propagation of the photons (electrons) is produced by the action of the protons, their "spin" is connected with the structure of the atom, that is to say with the position which the protons in the atom take up with respect to one another. The actual velocity of light can in this way be the same for all light-producing elements; the emissionary character of the photons, however, involves the fact that the photon (electron) also shares in the velocity of the light source. That the velocity of light is the same for all light-producing elements is thus closely connected with the recognition of the proton as the unit of matter and (gravitational) force. Every proton therefore has the same influence on the actual velocity of propagation of the photons (electrons). The way in which the atom is built up from its protons on the other hand must explain the spectrum.

RELATION BETWEEN THE EXPANSION AND THE MEAN DENSITY OF THE UNIVERSE.

A. Einstein and W. de Sitter in the *Proceedings of the National Academy of Sciences,* March 15, 1932, in a short paper (communicated by the Mount - Wilson Observatory) show that a relation may be established between the expansion of the universe—as indicated by the red-shift of the spectral lines of extra-galactic nebulæ—and its mean density. This paper is a very short one so that it can be re-stated here practically *in toto.* The original wording is largely adhered to, and the equations are, as will be seen, brought into level setting by the use of round brackets, in order to save expense and to economise space.

The field equations of the general theory of relativity involving in solutions a non-static state of the universe, as implied by the title above, taken with constant density, do not necessarily imply a positive curvature of three-dimensional space, though this curvature may be positive, negative or zero. This circumstance was pointed out by Dr. O. Heckmann (*Göttinger Nachrichten,* 1932, *2,* 126). In this case the only directly-observed data are: The mean density, and the expansion proving that the actual universe is in a non-static state. There is no corresponding direct evidence of the curvature of space, and therefore from the directly-observed data "we can derive neither the sign nor the value of the curvature, and the question arises whether it is possible to represent the observed facts without introducing a curvature at all." The term containing the cosmological constant λ was originally introduced into the field equations to account theoretically for a finite mean density in a static universe. "It now appears that in the dynamical case this end can be reached without the introduction of λ." Supposing the curvature to be zero, the line-element is: $ds^2 = -R^2(dx^2 + dy^2 + dz^2) + cdt^2$ [Eq. 1], where R is a function of t only, and c is the velocity of light. Neglecting, for the sake of simplicity, the pressure p (which is relatively negligible), without λ the field equations lead to two differential equations, of which only one is needed that, in the case of zero curvature, reduces to: $(1/R)^2(dR/cdt)^2 = \kappa\rho/3$. [Eq. 2]

Observations give the coefficient of expansion as: $(1/R)(dR/cdt) = h = 1/R_B$; and the mean density as: $2/\kappa R^2_A = \rho$. Therefore from Eq. 2 the theoretical relation $h^2 = \kappa\rho/3$, or $R^2_A/R^2_B = 2/3$ [these being Eqs. 3 and 3^1]. Taking for the coefficient of expansion $h = 500$ km. per second per 10^6 parsecs [Eq. 4], or $R_B = 2 \times 10^{27}$ cm., it is found that $R_A = 1.63 \times 10^{27}$ cm., or $\rho = 4 \times 10^{-28}$ gr. cm.$^{-3}$ [Eq. 5], which coincides exactly with the upper limit for the density adopted by de Sitter (*Bull. Astronom. Inst. Netherlands, Haarlem,* 1931, *6,* 142). h depends on the

red-shifts without appreciable uncertainty, but the distances of the extra-galactic nebulæ are still uncertain. "The density depends on the assumed masses of these nebulæ and on the scale of distance, and involves, moreover, the assumption that all the material mass in the universe is concentrated in the nebulæ," the latter probably without much uncertainty. With this assumption, the ratio h^2/ρ, or R^2_A/R^2_B from observations, "becomes proportional to Δ/M, Δ being the side of a cube containing on the average one nebula, and M the average mass of the nebulæ." The above values correspond to $\Delta = 10^6$ light years, $M = 2 \times 10^{11}$ $\times$ sun's mass, "which is about Dr. Oort's estimate of the mass of our own galactic system." Although the density is given by Eq. 5, corresponding to the assumed zero curvature and to the coefficient of expansion, the value of Eq. 4 "may perhaps be on the high side, it certainly is of the correct order of magnitude, and we must conclude that at the present time it is possible to represent the facts without assuming a curvature of three-dimensional space. The curvature is, however, essentially determinable, and an increase in the precision of the data derived from observations will enable us in the future to fix its sign and to determine its value."—F. H. L.

NICKEL STEEL PLATES.

The increasing use of alloy steels in general engineering is an interesting sign of the desire to take advantage of the higher stresses for which these materials are useful, whilst at the same time reducing weight.

Keeping pace with this trend the Appleby (Lincs.) works of The United Steel Companies Limited, which has previously manufactured only mild and medium carbon steels for boiler, ship, bridge, tank and similar structural purposes, is now manufacturing nickel steel plates in all sizes from $\frac{1}{8}$ in. thick upwards.

Nickel steel plates are now in much use for automobile and heavy vehicle chassis frames, brake drum pressings, as well as for structural engineering purposes, bridge and railway work.

SOVIET CHEMICAL INDUSTRY.

The chemical industry of pre-war Russia was at such a low level of development as to be the least in world importance in the production of chemicals. There used to be numerous chemical enterprises of a small nature, mostly making pharmaceutical goods, perfumes, matches, rubber articles, etc., which products are not now included in the basic chemical industry of the Soviet Union. The total output of the chemical industry of pre-war Russia in 1913 was 336 million roubles.

The rapid growth of industrialisation in the Soviet Union and the reconstruction of agriculture necessitated a vigorous development of the chemical industry, which has proceeded at a pace to give it one of the foremost places in world production of chemicals.

In 1928-29, the gross output of the State chemical industry of the U.S.S.R. was 884.2 million roubles, a considerable advance on the pre-war output of Russia in 1913. By 1929-30 the output of chemicals in the Union was valued at 1,126 million roubles.

During the last few years many big new chemical factories have been built and put into operation, like the Chernoretchinsk and Constantinivsk great chemical combines, and the big works at Bereznikov, Bobrikov, Voskrasensk, which were started this year.

This year the estimated production of the Soviet chemical industry is 1.5 milliard roubles. In 1931 the output of superphosphates in the U.S.S.R. exceeded that of Great Britain and Belgium. The estimated production of superphosphates in 1932 is 850,000 tons, which will make the Soviet chemical industry the third in world importance, being preceded only by that of the United States and France.

The output of sulphuric acid is also increasing rapidly, and is estimated this year to reach 830,000 tons, which is 100 per cent. more than the production in 1931. Whereas in 1931 the Soviet Union was the sixth in world importance in the production of sulphuric acid, this year it will be third, coming after France and Germany.

The raising and working up of the raw material for the chemical industry is also being developed at a great rate. Potassium

and apatite are the first to deserve mention. The Soviet Union has the largest natural resources of these minerals in the world. This will insure a plentiful supply of the raw material for the extensive production of potassic and phosphatic fertilizers. Potassium mines are now being sunk in Usol and Solikamsk, where an enriching works is in course of construction and an alkali factory is to be built.

In Khibinogorsk there is a big chemical combine, which raises apatite and has enriching works there. Hundreds of thousands of tons of enriching apatite are now being sent from Khibin to the superphosphates works in the Union.

ADVISORY COMMITTEE ON IMPORT DUTIES.

Views of I.C.I. Director.

Mr. H. J. Mitchell, Director, Imperial Chemical Industries, in an interview on Friday last stated that the scheme put forward by the Committee is evidently intended to be a provisional one. I am glad to note that the Committee fully recognise, as Imperial Chemical Industries has always done, that the proper organisation and equipment of an industry is fully as important for its well-being as tariff protection.

The scheme is to be varied, as the result both of the detailed investigations into the conditions of individual industries which the Committee declare their intention to make, and of experience in the actual working of the tariff. No doubt there will be dissatisfaction in some quarters; where it may be thought that the recommendations are insufficient. But industrialists generally will agree that the Committee are right in not plunging at once into a system of high duties, but yet putting an end to the uncertainty which has been hampering many industries, by giving an immediate measure of security. In that connection one must welcome especially the announcement that the Committee are not going to make recommendations for reductions of the duties now imposed for a period of at least a year. On the other hand, industries are to be given the opportunity of making reasoned applications for higher duties, and there will be general satisfaction at the Committee's promise to deal with all such applications as quickly as possible. A scientifically constructed tariff can obviously be worked out only gradually, but the Committee seem to me to have started on their task in the right way, and in a spirit which will be generally approved and be very encouraging to British industry. So far as the chemical industry is concerned, the first instalmeut will certainly be helpful.

WILL HYDROGEN BE A PORTABLE SOURCE OF POWER IN THE FUTURE?

According to a newspaper report Herr Hermann Honnef proposes to build a huge tower of steel carrying five wind-wheels 240 feet in diameter each, this tower to be erected in Berlin for supplying power. Cheapness of power production is anticipated. The electricity to be generated by this means could also be used, it is stated, for the production of hydrogen which in turn could be used explosively in engines. A number of Berlin motor-omnibuses appear to be already driven with hydrogen. It is suggested that the farmers could be supplied with cheap electricity. The magnitude of the undertaking is such that one wonders whether the astronomical bodies will not soon become jealous of man's achievements on this small planet. The figures given are not exactly astronomical, but they certainly are big, for the single tower is to develop 50 million kilowatts per year—presumably kilowatt hours are meant. It appears that the German government is interested in the scheme, but more anon.

CELLULOID INDUSTRY IN JAPAN.

The celluloid industry has a rather long history in this country, the treatment on imported raw celluloid was commenced fifty-five years ago, however the celluloid stuff manufacturing as a paying enterprise was established comparatively recently after numberless failures. As in the case of most Japanese manufactures, the celluloid industry received immense stimulus upon the outbreak of the World War. There are extremely wide varieties in celluloid manufactures;

among the most extensively used are such articles as combs, handles of brushes, toys etc. These goods are manufactured by many small factories and celluloid stuff is produced by a few large factories, say the Dai Nippon Celluloid Company which is the largest supplier of celluloid stuff in Japan and is controlled under the Mitsui interest.

At the point of raw material, Japan is blessed with abundant natural camphor, the Japanese production of natural camphor is about 4,000,000 lbs. yearly in which about 62% is consumed for celluloid manufacturing. The yearly celluloid production is about Y 4,000,000, and the most of these celluloid goods are produced in Osaka and Tokyo.

Celluloid articles are exported in no small quantity to different countries. China buys mostly combs and toys. India, Australia, and South America purchase largely combs, bracelets, toys, spectacle rims, collars and cuffs, etc., and the United States buys toothbrush handles.

The celluloid exportation during the past 10 years are as follows:

Year.	Value.	Year.	Value.
1921	Y 209,426	1926	Y 795,885
1922	203,317	1927	840,093
1923	355,476	1928	1,015,275
1924	584,905	1929	1,834,136
1925	510,320	1930	1,268,907

The principal countries producing celluloid articles are Germany and the United States. German products are relatively reasonable in price and substantial in quality, due primarily to large and systematic production. In China and the South Seas, the German goods compete with Japanese goods. American goods are also of high quality and substantial, though rather high in price. Since America has a greater demand for celluloid goods than she can herself supply, there is room for the export of Japanese goods for the United States. Unfortunately, this possibility has been largely forestalled by the rise in customs tariff which was enforced in 1930. The adverse effect of this measure has been greatly felt by the celluloid goods manufacturers in this country.

AMERICAN FRIEND OF CROOKES JOINS THE EDITORIAL BOARD OF *THE CHEMICAL NEWS.*

We are pleased to announce that Professor Nicholas Knight, Head of the department of Chemistry of Cornell College, Iowa, has joined our Editorial Board, making yet another well known chemist and educationist who subscribes to our policy of international distribution of knowledge.

Professor Knight was born at Mexico, New York in 1861 and was educated at New York Academy, Syracuse, Havard, Cornell, John's Hopkins and Strassbourg, graduating, A.B., A.M., Ph.D., and was a Courtesy Fellow of John's Hopkins 1894/5, 1898/9. He was Professor of Natural Philosophy, Cazinoria Seminary, New York, 1882-92.

Professor of Chemistry, Randolf-Macon College, Virgina, 1895-8 and in 1899, joined the Faculty at Cornell remaining there until the present time.

His publications include:—

Quantitative Chemical Analysis
Blow Pipe Analysis.
Chemical Arithmetic.
Chemistry of Colloids.

Professor Knight has contributed over 300 scientific papers to the leading journals throughout the world, including the *Chemical News.* In 1920/1 he was President of *The Iowa Academy of Sciences* and was recently elected a Vice-President for U.S.A. of *The Faculty of Sciences.*

The late Sir William Crookes was a close friend of Knight, who never missed an opportunity of visiting Crookes' laboratory and home, whenever he was travelling in Europe.

Professor Knight has prepared a personal article on the human aspect of Crookes' life, which will be published in the Special Crookes Centenary Number of the *Chemical News* in June.

IMPORTATION OF FERTILIZERS INTO JAPAN.

Foreign fertilizers imported into Japan during 1931 amounted to 1,984,000 tons worth Y 81,620,000, showing a 6 per cent. decline in value from 1930, according to the Japan Fertilizer Association. Great

decrease of demand for fertilizer in rural communities following the economic slump and the drop of prices account for the unfavourable business. Soya bean cake as usual led the list of imports and ammonium sulphate was second.

Ammonium sulphate imported last year amounted to 224,000 tons, declining about 80,000 tons from 1930. This is caused by the great increase in the production of this fertilizer in Japan, which suddenly advanced from 350,000 tons for 1930 to 600,000 tons for 1931.

TESTING WORK FOR THE BUILDING INDUSTRY.

In recent years there has been a growing demand on the Building Research Station of the Department of Scientific and Industrial Research for tests and reports on building materials and forms of construction. In order to enable the Station to cope with these requests, a panel of approved testing laboratories is being established to act in association with the Station. The essence of the scheme is to put the Station in the position to have tests carried out at laboratories on the panel and then to incorporate the results in Government reports or certificates issued by the Station. The bulk of the tests will probably be mechanical or physical; of the chemical tests most will probably be simple analyses.

Applications are invited from testing laboratories wishing to participate in the scheme. Further particulars and forms of application can be obtained from the Director, Building Research Station, Garston, Herts.

FERTILIZERS IN CANADA.

By Donald M. Marvin, Economist to The Royal Bank of Canada.

It is anticipated that in 1932, for the first time, the use of fertilizers in Western Canada will be on a commercial basis. Substantial results have already been achieved in the older sections of the country and extensive experimental tests in Western Canada have suggested remarkable possibilities. Last year's experiments were upon a sufficient scale to be thoroughly convincing to the farmers and large sales are now being made. As research continues and the benefits derived by the farmers become more widely known, the use of these artificial plant foods will be more general and this is bound to bring about extensive changes in our methods of agriculture. A large proportion of the fertilizer used is still imported, but Canadian companies are increasing their output of products especially adapted to Canadian requirements.

All plants are made of water and several chemical constituents which are necessary for their growth. These chemical constituents are taken by the plant from the air or from the soil. Among the most important elements taken from the soil are nitrogen, phosphoric acid and potash. Each of these elements plays a different part in the life of the plant. Nitrogen, for example, will help, amongst other things, to make the leaves and other green parts of the plant; phosphoric acid aids the plants to mature properly; potash increases yield and strengthens resistance to disease and unfavourable weather conditions. In many sections, particularly, after continued use of the land, there is not much nitrogen, phosphoric acid and potash to ensure satisfactory returns. All these elements, however, may be supplied to the soil in the form of chemical fertilizers, which are compound substances carrying these elements either separately or in combination and are used by the agriculturist to supply a deficiency in all or any of the three. Other chemical elements are also required in the soil for successful crop production, but they are generally available in sufficient quantities so that it is not necessary that they should be included in commercial fertilizers. An exception is calcium in the form of lime; a deficiency in lime must be made good but this element assists growth rather than constituting a plant food in itself. A common practice permits the addition in mixed fertilizer of filler, usually a spent moulding sand or ground limestone; both of these are inert, but improve the physical condition of the product so that it may be applied more readily to the soil.

It was over thirty years ago that the famous British scientist, Sir William Crookes, made the startling statement that unless we took advantage of the inexhaustible supply of nitrogen in the air to supple-

ment the Chilean nitrate, the world would eventually face starvation. This was one hundred and twenty-five years after the original discovery of nitrogen. Strange to say, however, it was not nitrogen for food, but nitrogen for war, that supplied the incentive for the discovery of methods of taking nitrogen from the air. Production continued after that incentive had been removed, and increased by 50 per cent. between 1925 and 1928. The world's capacity for producing natural and synthetic nitrogen is now estimated at 3,125,000 tons per annum against a total consumption of only 1,900,000 tons. The Canadian capacity for the production of nitrogen for all purposes is placed at 70,000 tons, but sales of mixed fertilizers during the year ended June 30, 1930, were reported to contain less than 5,000 tons. This, however, was more than 50 per cent. greater than the quantity used during the preceding year.

Phosphoric acid tends more particularly to promote the root development in the early stages of growth and the production of seed or fruit in the later stages. It also hastens the maturity of the crop, an important feature where delayed ripening from a cold or wet season or danger from early frosts constitute a menace.

Potash is essential to the formation of starches in potatoes and grains, the sugar of fruits and vegetables and the fibrous matter of plants. It also aids in the production of proteins and in the formation of well-developed grain. An ample supply of potash in the soil tends to reduce the susceptibility of crops to fungus attacks.

By stimulating growth, the addition of only one of these elements to the soil tends to exhaust the supplies of these other forms of plant food. To overcome this difficulty, mixed fertilizers have come into use. These are produced in various proportions to meet the needs of different crops and soils.

Various experiments and tests have been made of the results following the use of proper fertilizer. For the orchards of the Maritime Provinces and British Columbia, nitrogen and phosphoric acid have been produced in the form of fish meal. Fruit production has been found to be influenced in a marked degree by the supply of available nitrogen in the soil. Nitrogen alone, however, may result in too great a growth of wood and a balanced fertilizer has come into more general use. Colour, size and keeping qualities, as well as yield, have responded to the use of fertilizer in apple orchards.

Of all the ordinary farm crops, potatoes are perhaps most responsive to the use of fertilizer and it has been extensively used by potato growers for many years. Other vegetable crops, such as sugar beets and turnips, also respond readily to the application of fertilizer. Market gardeners are perhaps our most intensive cultivators and use large quantities of fertilizer in producing early crops of high quality vegetables and fruits for the city markets.

The use of fertilizer for the improvement of pasture land has developed in Canada only within recent years, but has long been practised in Great Britain, particularly on permanent pastures. The fertilizing and controlled grazing of pastures enables them to carry a larger number of animals. In dairy herds, milk production is increased, in beef herds and sheep, the rate of gain in weight is accelerated, because of earlier grazing in the spring, more abundance in summer and later grazing in the fall, with a correspondingly decreased requirement of commercial or grain feed.

The fertilizers which are coming into general use in Western Canada are ammonium sulphate and triple superphosphate. These are drilled in with the grain at the time of seeding by means of a special attachment to the seed drill, instead of being spread over the land as in Eastern Canada. The treated crop invariably showed stimulation early in growth with increased vigour of foliage and greater root development. The fertilizer apparently supplied the treated plants with food which the untreated plants in the check plots were not able to obtain under the relatively cold conditions existing in the soil early in the season. The treated plants were also able to make better use of the available soil moisture and to develop a more sturdy growth. The early growth of the plant tended to prevent soil drifting. Weed development and damage from insect pests and rust were also materially lessened. Early heading of the treated grain was one of the outstanding observations; differences

of from three to fourteen days were noted. Earlier maturity generally followed; in Manitoba and Saskatchewan this averaged five days in the 1930 experiments. Increases in yield ranging from 18 to 50 per cent. were reported with only a comparatively small proportion of the tests failing to show some gain. Differences in maturity were reflected in the subsequent handling of the crop and its market value. A week earlier in cutting meant several weeks' advance in threshing, and by avoiding wet weather and early frosts the commercial value of the grain was advanced. Major H. G. L. Strange, a former "Wheat King," had a demonstration field of eighty acres in 1931 in the Fenn district near Stetler, Alberta. Throughout the field the same quality of registered Marquis wheat seed was used; part was fertilized and the balance used as a check plot. On the fertilized section an average yield of 32 bushels per acre was secured as against 18 bushels on the unfertilized part. The wheat from the fertilized area graded No. 1, Northern; on account of frost damage, wheat from the unfertilized area graded No. 4. The fertilized area had been harvested seven days earlier and so escaped any damage from frost. The time factor is most important, particularly in a district sometimes subject to frost, but gains in yield and quality were also substantial. The cost of fertilizing ranges from 50 cents to $2.00 per acre, a trifling sum in comparison with the results achieved.

The tests mentioned above, which have shown substantial gains in increased yields and higher quality of grain, with less risk from soil drifting, rust and early frosts, constitute inducements which will popularize the use of fertilizer by the Western farmer. The quantities used in the East, where the value of fertilizer has long been recognized, are steadily increasing. In 1931, sales reports show Quebec farmers used four times the quantities which they had applied to the land three years before; their purchases were nearly as great as those of Ontario, where sales have also been increasing.

The tendency of modern civilization is to decrease the amount of effort required for each unit of production, and the scientific use of fertilizer is an important means to this end. Moreover, the continued use of the land tends to reduce the supply of plant food available in the soil, and agriculture, particularly in older sections, depends more and more on the use of plant food supplied to the land from outside sources. The increased demand for commercial fertilizers during the past few years, and new methods of research which have developed new ways of producing the elements required, have changed the entire picture of the fertilizer industry.

Proceedings and Notices of Societies.

GEOLOGICAL SOCIETY.

Meeting on April 27, 1932.

'The Stratigraphy, of the Valentian Rocks of Shropshire: the Longmynd-Shelve and Breidden Outcrops.' By Walter Frederick Whittard, Ph.D., A.R.C.S., D.I.C., F.G.S.

A dual division of the Valentian rocks of Shropshire into a lower group, the Pentamerus Beds, and an upper group, the Purple Shales, is here adopted. Further, two lithological subdivisions of the Pentamerus Beds, the Arenaceous Phase and the Mudstone Phase, are recognized.

The Longmynd-Shelve Outcrop is divided into several areas by glacial deposits. The rocks of these areas exhibit different lithological and faunal characters, due to the variable conditions under which they were laid down.

The faulting of the Longmynd-Shelve and Breidden Outcrops is mentioned; the Church Stretton Main Fault (F1) receives special treatment, because of the evidence which the Marshbrook Outlier provides with regard to the throw of the fault.

The graptolites from the Upper Valentian rocks of Shropshire favour a correlation of the shelly fauna with the *Monograptus turriculatus* and *Monograptus crispus* Zones of the Gala.

Two distinct faunas characterize the Valentian rocks of the Main Outcrop, and these are selected as the standard faunas. Several local modifications of each standard fauna are present in the Longmynd-Shelve and Breidden Outcrops. The character of the sea-bed and the

control it exerted on the kind of fauna which frequented a particular area is stressed, and attention is directed to the mud- and sand-loving genera and species.

The encroachment of the sea over the district in Upper Valentian times resulted in a complicated region of land and sea to which the name 'Salopia' is given. Alongshore structures, such as characterize many subsiding coastlines, are described from the Upper Valentian rocks. Remnants of the Valentian landscape are still preserved, and it is possible to reconstruct locally the configuration of the land.

Notices of Books.

The Chemistry, Flavouring and Manufacture of Chocolate, Confectionery and Cocoa. By H. R. Jensen, M.Sc., F.I.C. 9¾ ins. x 6 in., pp. xvi + 406. London: Messrs. J. & A. Churchill, 40, Gloucester Place, Portman Square. Price 27s. net.

Mr. Jensen has written a very informative and interesting treatise, which should be of great value to all chemists connected with the confectionery and allied industries. In an admirable Introduction, he takes British manufacturers to task for their failure to keep abreast of the times in processes and machinery, and outlines the functions of the chemist in industry. "The chemist," he very justly remarks, "too often alone knows how his work is to be made effective, and, in short, he needs to be treated as a vital productive as well as a protective unit."

The opening chapter deals very thoroughly with Cacao, the raw material of primary importance; after which come chapters devoted to Chocolate Manufacture, Chocolate Defects, Cocoa Powder, Confectionery Fats, Sugar Products, Milk Products, and Aggulinants, etc. Two chapters follow, of special interest to the present reviewer, dealing with Confectionery Flavours and the Essential Oils and other aromatic materials used for flavouring chocolate and other forms of confectionery. In his Preface, the author refers to the "decisive importance and inexcusable neglect" of this subject, which he has treated with commendable fullness.

Much useful information, including details about chemical constituents, is given concerning the essential oils used for the flavouring purposes. In the case of the essential oils of Angelica (*Archangelica officinalis* Hoffm.), a clearer distinction should have been drawn between the fruit and root oils, which are by no means indentical chemically or in aroma. The latter appears to contain the lactone of 14-oxytetradecane-l-carboxylic acid, to which the peculiar musk-like note in its aroma is due.

In the case of cacoa itself, the author calls attention to the pioneer work of Messrs. Bainbridge and Davies, who obtained a yield of 0.001 per cent. of essential oil from the exceptionally aromatic Arriba cacao by distillation, and identified some of its constituents, including *d*-linalol. He expresses surprise, and the present reviewer shares his sentiments, that this work, in spite of its technical importance and scientific interest, appears to have been carried no further.

Lemon oils (including terpeneless) and vanilla are, in view of their great importance, dealt with very fully; and some very interesting information is collected together relating to the extraction and chemistry of natural fruit flavours. Some detailed information is also given concerning artificial flavours, the author taking care to emphasise the great superiority of natural vanilla to synthetic vanillin, and natural S.A.P. bitter almond oil to synthetic benzaldehyde. A number of basic formulæ for artificial flavours are given.

Concerning solvents, it should be noted that ethylene glycol, which, however, Mr. Jensen says is of little practical value owing to its low solvent powers, has recently been shown to be toxic, presumably owing to oxidation to oxalic acid in the body.

The final chapters of this really excellent book deal with Confectionery Colours (a little too briefly), Analytical Notes and Chocolate and Cocoa Standards. Mr. Jensen is of the opinion that definite standards should be set up for these products in this country, as in America, Australia and many European countries, and again, there is one reader, at least, in cordial agreement with him.

H. S. R.

La Stampa Plastica E le Industrie della Gomma. (Italian Plastics and Rubber Year Book) Milan. Casa Editrice Pollini. Via Torino No. 47. Price 6s. post free. 144 pp.

This book is an interesting work (in Italian with bi-lingual Preface) on the advances and present position of the Plastics and Rubber Industries. It contains many pages of displayed advertisements relating to manufacturers' announcements the world over and many hints are interspersed throughout the book—which if followed, will enable traders of other countries to deal with Italians more effectively. The industries covered by this book have not progressed in Italy so far as have others, *i.e.* electrical, etc., and it would appear that Italy is still a fruitful field for the development of these industries. The aim of the work appears to be to bring before the Italian manufacturer and trader, the leading companies catering for their needs, by means of editorial comment and displayed advertisements.

The same publishers are shortly issuing an Italian Paint and Varnish Year Book and the foreign department of Pollini will be glad to answer all enquiries.

We have received a copy of the April issue of *Proteus,* a journal of the Science, Philosophy and Therapy of Nature, Edited by Dr. W. B. Crow, head of the Department of Biology, Huddersfield Technical College, and published at 140, The Grove, Stratford, London, E. 15. The subscription is 10s. per annum for four quarterly issues.

The object of this journal is to present Scientific, Philosophical, Historical and Technical

articles on General Morphology—the inter-relation of the different branches of biological and natural therapeutic procedures, and studies of Psychological make-up, etc.

The present number is a Goethe Commemoration Number and in addition to some very interesting Editorial analyses of Goethe's nature and work by Dr. Crow, Dr. Henri M. Leon, the secretary-general of the Société Internationale de Philologie, Sciences et Beaux Arts has presented a fine paper on the origin and development of the Faust Legend. The number makes pleasant reading and is a fine endeavour to present the more scientific aspect of Goethe's life-work

New Patents.

These particulars of New Patents of interest to readers have been selected from the Official Journal of Patents and are published by permission of the Controller of H.M. Stationery Office, and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

Latest Patent Applications.

9685.—Fairweather, D. A. W. & Imperial Chemical Industries, Ltd.—Manufacture, etc., of N-sulphonic acids of carboxylamides. April 4th.

Specifications Published.

370,039.—Bernhauer, Dr. K.—Production of organic compounds by biochemical action.

370,211.—I. G. Farbenindustrie Akt.-Ges.—Process for the manufacture of alkyl halides.

370,289.—Humphreys & Glasgow, Ltd. Production of hydrogen.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, at the uniform price of 1s. each.

Abstract Published.

363,909.—Decomposing aluminium phosphates—Chemische Werke, Vorm, H. & E.—Albert Biebrich, Wiesbaden, Germany.

Aluminium phosphate is dissolved in boiling caustic alkali, for example, caustic soda, the solution is cooled, say to 15° C., to crystallize alkali phosphate, and the mother liquor is employed with fresh caustic alkali to dissolve a further quantity of aluminium phosphate. This operation is repeated several times, the alkali phosphate becoming progressively more insoluble as the concentration of the alkali aluminate increases, until the solution reaches a certain concentration, when, after precipitating residual phosphoric acid with lime or other suitable metal oxide, it is treated in known manner for the recovery of alumina.

The Specification as open to inspection under Sect. 91 (3) (a) comprises also the following subject-matter:—The solution obtained by dissolving aluminium phosphate in caustic alkali is treated with organic or inorganic bases forming insoluble phosphates, and the alkali liquors filtered therefrom are returned for further decomposition. Thus, the solution may be precipitated with baryta, and the barium phosphate treated with sulphuric acid. Barium sulphate filtered from the phosphoric acid is converted to barium sulphide, and this with hydrochloric acid to barium chloride. Hydrogen sulphide evolved is converted to sulphuric acid for re-use, and the barium chloride is treated with sodium nitrate to produce barium nitrate, from which baryta is obtained. Sodium chloride produced is reacted with sulphuric acid to produce hydrochloric acid and sodium sulphate for re-use. In another example, the alkali aluminate-phosphate solution is treated with silver nitrate. Silver phosphate, sodium nitrate, and alumina are deposited, residual soda solution being returned to the leaching. The precipitate is treated with ammonia producing soluble silver-ammonium phosphate, (subsequently decomposing) and a residue of alumina. The silver phosphate is treated with hydrochloric acid to give phosphoric acid and silver chloride, which latter is decomposed to silver and chlorine. The silver is dissolved in nitric acid, and the chlorine converted to hydro-chloric acid, both products being re-used in the process. Sodium nitrate produced in the process may be converted to potassium nitrate, or may serve for the oxidation of sulphur dioxide produced during the decomposition of sodium-aluminium phosphate by heat (?), or it may be reacted with the barium chloride obtained in the previous example to produce barium nitrate and sodium chloride. This subject-matter does not appear in the Specification as accepted.

The Latest Trade Marks.

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of H.M. Stationery Office, and the Trade Marks Journal can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

THORLENE.

530,280.—All goods in Class 1 which includes chemical substances used in manufactures, photography, or philosophical research and anti-corrosives.—Samuel Thornley Limited, 6, Snow Hill, Birmingham. April 13.

BLACK LEAF 40.

B529,610.—Chemical substances used for agricultural and horticultural purposes.—Tobacco by-Products and Chemical Corporation, 1,350, South Seventieth Street, City of Louisville, County of Jefferson, State of Kentucky, United States of America. April 13.
User claimed from 28 February, 1919.
The Applicants undertake that this Mark, when registered, and the Marks Nos. 386,183 (2,126) ii and 506,514 (2,817 ii shall be assigned or transmitted only as a whole and not separately.

THE CHEMICAL NEWS

General Offices: MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4. *Telephone:* Central 4960

All communications (other than advertising matter) to be addressed to the Editor, Chemical News. Communications appertaining to Advertisements to be addressed to the Advertisement Manager. The Editor does not accept responsibility for views expressed in any article or contribution published

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THE STRUCTURE OF ATOMIC NUCLEI

By LORD RUTHERFORD, O.M., F.R.S.†

(ensuing discussion participated in by Dr. J. Chadwick, F.R.S., Dr. C. D. Ellis, F.R.S., Professor R. H. Fowler, F.R.S., Professor J. C. McLennan, F.R.S., Professor F. A. Lindemann, F.R.S., and N. F. Mott.)

In my address to-day, I shall briefly review some of the main lines of advance in our knowledge of atomic nuclei since the last discussion* which I had the honour to open. In the interval, there has been substantial progress in many directions, and new and promising methods of attack on this formidable problem have been opened up. I can only refer in passing to the valuable data obtained by Aston and others on the isotopic constitution of the elements and the relative abundance of the isotopes of many of the elements. This has made it possible to determine the chemical atomic weight of many elements with considerable accuracy by the use of the mass spectrograph. A number of new experiments have been made to determine with accuracy the relative quantities of the isotopes of lead, and in particular of lead obtained from pure uranium and thorium minerals of great geological age. Data of this kind are of much interest and importance, not only from the point of view of radioactivity but also with regard to the fixation of an accurate time scale in geology. It seems certain that the end product of the actinium series—actinium lead—has an atomic mass 207 and that actinium is derived from the transformation of an isotope of uranium. From the relative abundance of actinium-lead and uranium-lead derived from old radioactive minerals, it is possible to deduce the average life of this uranium isotope. I pointed out some time ago in *Nature*, that important inferences could be drawn with regard to the production of elements in the sun from a consideration of the average life of the two uranium isotopes.

† Discussion held at the Royal Society on Thursday, April 28, 1932, at 4.30 p.m.

* 'Proc. Roy. Soc.,' A, vol. 123, p. 373 (1929).

Optical Methods.—One of the most interesting developments in recent years has been the application of optical methods to determine the presence of isotopes and to throw light on the movements of the nucleus. The study of the band-spectra of the molecules of the lighter elements had disclosed the presence of isotopes existing in small quantities compared with the main isotope. It has been shown that oxygen consists of three isotopes of masses 16, 17, 18, carbon 12, 13, beryllium 8, 9, boron 11, 10, while recent observations of Urey, Brickwedde and Murphy are believed to indicate the presence in small quantity in hydrogen of a new isotope of mass 2. Attempts are in progress to concentrate the new isotope by fractional distillation of liquid hydrogen.

In addition to identifying lines due to new isotopes, considerable attention has been directed to the relative intensities of the lines in the band spectra. Not only does this yield information about the spin of the nucleus but is also provides a method of attack on one of the most fundamental points of nuclear physics, namely whether the members of a given isotopic system are identical.

During the last few years, there have been many researches to determine the hyperfine structure in optical spectra. This gives another line of attack on the difficult problem of spin of the nucleus. I shall leave to Professor R. H. Fowler the task of discussing the data obtained and the conclusions that can be drawn.

Application of Wave-mechanics.—In the last discussion reference was made to the application by Gamow and by Gurney and Condon of the then new wave-mechanical ideas to certain nuclear problems, and in particular to the explanation of the well-known Geiger-Nuttall rule connecting the velocity of escape of an α-particle from a radioactive substance and its transformation constant. On this theory it was supposed that the nucleus was surrounded by a high positive potential barrier, and that α-particles and other nuclear constituents within this barrier were held in equilibrium by strong but unknown types of attractive forces. On such a model, there is a finite probability that the α-particle in the nucleus can escape through the barrier without loss of energy, the probability increasing rapidly with increase of the energy of the α-particle. This general conception of the nucleus has proved very valuable in a number of directions and has been a very useful working guide to the experimenter. Unfortunately it has not so far been found possible on the theory to give any detailed picture of the structure of a nucleus. It is generally supposed that the nucleus of a heavy element consists mainly of α-particles with an admixture of a few free protons and electrons, but the exact division between these constitutents is unknown. On the theory, there is a great difficulty in including within the minute nucleus particles of such widely different masses as the α-particles and electron. In addition, the nucleus is such a concentrated structure, and the constituent particles are so close together, that the theory of the action of one particle on another, applicable under ordinary conditions, cannot be safely applied for such minute distances.

It appears as if the electron within the nucleus behaves quite differently from the electron in the outer atom. This difficulty may be of our own creation for it seems to me more likely that an electron cannot exist in the free state in a stable nucleus, but must always be associated with a proton or other possible massive units. The indication of the existence of the neutron in certain nuclei is significant in this connection. The observation of Beck, that in the building up of heavier elements from the lighter, electrons are added in pairs, is of much interest and suggests that it is essential to neutralise the large magnetic moment of the electron by the addition of another for the formation of a stable nucleus. It may be that uncharged units of mass 2 as well as the neutron of mass 1 may be secondary units in the structure of nuclei.

While no definite theory of the nucleus seems at present feasible, yet much progress can be made by the use of suitable analogies based on the general model of the nucleus previously outlined. For example, Gamow has drawn important inferences with regard to the mass defect of the lighter atoms composed of α-particles, *i.e.*, of elements of the type $4n$, on the analogy that the forces in the nucleus resemble in a general way those acting in a minute drop of water. In addi-

tion he has discussed in an illuminating way the conditions to be fulfilled for the formation of stable nuclei of high atomic number. Unfortunately, the masses of the isotopes of many of the elements require to be known with much greater accuracy before much further progress can be made in this problem along these lines.

In another direction, too, it has been found fruitful to apply to the nucleus many of the general ideas of energy levels which have proved so useful in discussing the electronic structure of the outer atom. It has long been supposed that the quantum laws hold within the nucleus, and the correctness of this assumption has been abundantly verified in recent years. It will be seen that the conceptions of energy levels and of excitation of nuclei have proved of great utility in much recent work on the difficult problem of the origin of the γ-rays, and in understanding the observations obtained in the study of the artificial disintegration of the elements.

Origin of the γ-rays.—It has long been recognised that the γ-rays originate in the nucleus and represent in a sense the characteristic modes of vibration of the nuclear structure. The interpretation of the complicated γ-ray spectra shown by the radioactive elements has, however, been rendered difficult by our ignorance of the origin of this radiation—whether it arises from the constituent electron, proton or α-particle, or from the nucleus acting as a single entity. During the last few years, there has been a vigorous attack on this problem, and it now seems clear that the nuclear γ-rays are due to the transition of an α-particle between energy levels in an excited nucleus. Two different lines of attack have been developed depending on—

(1) a study of the long range α-particles from radium C and thorium C;

(2) the fine structure shown in the α-particles emission from certain radioactive substances.

It may be supposed that the emission of a β-particle during a transformation causes a violent disturbance in the resulting nucleus, some of the constituent α-particles being raised to a much higher level of energy than the normal. These α-particles are unstable, and after a very short interval fall back to the normal level, emitting their surplus energy in the form of a γ-ray of definite frequency, defined by the quantum relation. In this short interval, there is a small chance that some of the α-particles in the higher levels may escape through the potential barrier of the nucleus. On this point of view, the escaping α-particles from the different levels represent the groups of long range α-particles observed. The energy of the escaping α-particle gives the value of the energy level occupied by the α-particle before its release in the excited nucleus.

To test this hypothesis, the long range α-particles from radium C have been carefully analysed, using the new counting methods, by a group of workers, Wynn Williams, Ward, Lewis and the writer, and found to consist of at least nine distinct groups. The difference of energy between the various groups were found to be closely connected with the energies of some of the most prominent γ-rays, and in general the experiments gave strong evidence that the γ-rays had their origin in the transitions of one or more α-particles in an excited nucleus. At the same time, the experiments gave us direct information of the magnitude of a number of the possible energy levels in this particular nucleus.

In the great majority of cases, the α-particles in a radioactive transformation are expelled with identical speed. Rosenblum, however, showed that the element thorium C emitted not one but five distinct groups of α-particles, and evidence of a fine structure in the α-rays has since been obtained for other radioactive bodies. Gamow pointed out that γ-rays should arise in all cases where such a fine structure in the α-rays was present. Owing to certain technical difficulties in the case of thorium C, it has been difficult to give clear-cut evidence of the correctness of this point of view. Ellis and also Rosenblum conclude that Gamow's view is correct, but Meitner reached an opposite conclusion.

I can only refer in passing to some recent experiments of Mr. Bowden and myself for the proof of the emission of γ-rays from the actinium emanation, which Lewis and Wynn Williams found emitted two distinct groups of γ-rays. The results seem to me to

support the general correctness of the theory that a fine structure in the emission of α-rays is always accompanied by the appearance of γ-rays. I shall leave to a later speaker, Dr. Ellis, the task of dealing more adequately with the present situation of this important problem.

When once the origin of the γ-rays is definitely settled there is a reasonable prospect of attacking successfully the whole question of the interpretation of γ-ray spectra in general, in which so far only a beginning has been made. It is obvious that a closer understanding of this problem may be expected to throw much light on the detailed structure of the nucleus. It is of great importance for this purpose to determine the spectrum of the γ-rays with the greatest possible precision, and this will entail many years of work.

Before leaving this part of the subject, I should like to emphasise the remarkable difference between the emission of an α-particle and a β-particle in disturbing a nucleus. Strange to say, the escape of an α-particle either does not excite a nucleus at all, or only raises one more of the constituent α-particles to a comparatively low level of energy above the normal. In many cases, however, the escape of a β-particle causes a violent excitation of the residual nucleus, some of the α-particles being raised to a very high level of energy and with the emission of high energy γ-rays. This difference between the effects of the two types of particle is very striking and may be intimately connected with the processes which cause the emission of a β-particle from a radioactive element.

Whenever we have to deal with the behaviour of the electron in the nucleus, we find grave difficulty in applying our theoretical ideas. The most striking instance is perhaps that radioactive nuclei of the β-ray type emit electrons with a wide range of energy, and that there appears to be no compensating process which would permit of that definite energy balance to be expected on quantum dynamics. This is undoubtedly one of the most fundamental problems today, but it is unlikely that we shall have sufficient time to discuss its theoretical implications.

Excitation of Nuclei by γ-rays.—Until recently, it had been generally supposed that the absorption of X-rays and γ-rays was due entirely to the interaction of the radiation with the extra nuclear electrons, and that the nucleus itself took no part in the process. It is now clear that if the quantum energy of the γ-rays exceeds about 2 million volts, an additional type of absorption appears with ordinary nuclei, accompanied by the emission of characteristic radiations of different frequencies from the primary. This effect of the nucleus on the absorption has been brought out by the work of Chao, Meitner, Hupfield, Tarrant and others using the penetrating γ-radiation from thorium C″ of energy about 2.65×10^6 electron-volts. In a paper now in course of publication by this Society, Gray and Tarrant give the results of a detailed examination of this nuclear excitation by different elements. Not only γ-rays from thorium C″ have been used, but also the high frequency components in the radiation from radium C′. They conclude that this nuclear excitation is a general property of the elements at any rate between oxygen and lead. Characteristic radiations of similar type appear to be emitted by all the elements, the intensity of the radiation from different elements varying approximately as the square of the atomic number. These characteristic radiations from the nucleus which appear to be emitted uniformly in all directions, can be resolved into two components of quantum energy about 500,000 and 1,500,000 electron volts. In explanation they suggest that the γ-radiation does not excite the nucleus as a whole, but some constituent like the α-particle which is common to all the elements. It may be that the characteristic radiations observed represent some of the modes of vibration of the α-particle structure itself. It will be of much interest to pursue these important investigations further, but progress is hindered by the difficulty of obtaining strong sources of high frequency radiation over a wide range of quantum energy. The excitation of the nucleus by high frequency radiation is no doubt intimately connected with the processes which give rise to the γ-rays from a radioactive nucleus, and may help to throw further light on this problem.

Artificial Transmutation.—In the last few years there has been a rapid increase of our knowledge of the artificial transmutation of light elements by bombardment with α-particles. This has been largely due to the development of new electrical methods of counting α-particles and protons in place of the useful but trying scintillation method. Pose first showed that some of the protons ejected from aluminium appeared in groups of definite velocities. Our knowledge has been extended by the work of Pose, Meitner, Bothe, de Broglie and Ringuet and Chadwick and Constable. For example, Chadwick and Constable have resolved the protons liberated from aluminium by the α-particles of polonium into eight distinct groups connected in pairs. In explanation it is supposed that the protons or α-particles in the bombarded nucleus occupy definite energy levels. It is supposed, following the suggestion of Gurney, that there is a much greater chance of entering the potential barrier of the nucleus owing to resonance if the bombarding α-particle has about the same energy as that of the proton or α-particle in the nuclear level. For a given energy of α-particle, two groups of proton are emitted corresponding it is believed to two distinct processes of capture of the α-particle by the nucleus. Similar results have been observed in fluorine and other light elements. It has been found that these resonance levels for privileged capture of the α-particle are fairly broad, corresponding to about 5 per cent. of the energy level. The results as far as they have gone have yielded important information on the values of the energy levels of light nuclei, and with the use of still swifter particles than those from polonium we may expect to extend our knowledge of these levels still further.

In interpretation of these experiments, it has been implicitly assumed that the laws of the conservation of energy and momentum apply. In this way it has been possible to calculate with considerable accuracy the atomic mass of the element resulting from the capture of the α-particle and the emission of the proton.

When two groups of protons of different speeds are connected with a single resonance level, it is found that γ-rays appear of quantum energy corresponding approximately to the difference of energy of the protons in the two groups. The study of the γ-radiations emitted during artificial transmutation has in the last few months led to new and interesting developments. Bothe and Becker in 1930 found that the element beryllium when bombarded by α-particles did not emit protons but gave rise to what appeared to be a γ-radiation of penetrating power greater than the γ-rays from radium C′.

The absorption of this radiation by matter was examined by Mme. Curie-Joliot and Joliot, and also by Webster. This year Mme. Curie-Joliot and M. Joliot observed by the ionisation method that this radiation emitted protons of high velocity from hydrogen material. It was at first suggested that the swift protons might be due to an interaction between the γ-ray quantum and the proton, but this required the quantum energy of the radiation to be very high, of the order of 50 million volts. As a result of further experiments by electrical methods of counting, Chadwick found that a similar recoil could be observed for all light atoms, and concluded that the effects might be explained on the assumption that a stream of swift neutrons were liberated from the beryllium nucleus. It is not easy to distinguish between these two suggestions but sufficient evidence has been accumulated to show that this new type of radiation has surprising properties and is able to produce disintegration in nitrogen, probably in a novel way.

I shall leave to Dr. Chadwick to give you a fuller account of the work on artificial transmutation and on the properties of this new type of radiation.

The idea of the possible existence of "neutrons," that is, of a close combination of a proton and an electron to form a unit of mass nearly 1 and zero charge is not new. In the Bakerian Lecture before this Society in 1920, I discussed the probable properties of the neutron, while the late Dr. Glasson and J. K. Roberts in the Cavendish Laboratory made experiments to detect the formation of neutrons in a strong electric discharge through hydrogen but without success. If the neutron hypothesis be con-

firmed by experiment, it will obviously much influence our conception of the formation and constitution of nuclei. Many years ago in a lecture before the Royal Institution, I discussed the possibility of the formation of heavy nuclei from hydrogen through the intermediary of the neutron. It seems not unlikely that the neutrons, owing to their mutual attraction may collect in massive aggregates which in course of time by the processes of disintegration and association, re-arrange themselves to form the nuclei of the stable elements. I merely throw out this old idea as one possibly worthy of further consideration in the light of later knowledge.

Scattering of α-particles.—In previous discussions attention has been directed to the anomalous scattering of α-particles by light elements, and the difficulty of interpretation of the results obtained. Many of these difficulties have been removed by the application of the wave-mechanical ideas to these problems. For example, H. M. Taylor has been able to account in considerable detail for the anomalous scattering of α-particles observed both in hydrogen and helium, by simple considerations based on the wave-mechanics. Mott drew attention to the anomalies to be expected in the scattering of low velocity α-particles by helium, and his conclusions have been amply confirmed by the work of Chadwick and Blackett and Champion. On the theory of Mott, similar anomalies are to be expected in collisions between two identical nuclei of any kind.

General.—I have endeavoured in the above review to bring to your attention what appear to me the most important lines of experimental attack on the problem of the structure of atomic nuclei. I have not entered into speculative questions like the possibility of the annihilation of matter and its conversion into radiation, nor have I referred to the guesses, which we may hope will prove inspired, of the numerical relation between the unit of charge and Planck's constant h or of the relation between the masses of the electron and proton; nor have I entered, except in an incidental way, upon the difficult question on which much has been written of the formation and transformation of nuclei, under the influence of conditions existing in hot stars.

In making this review, I have been struck by the comparatively rapid progress that has been made since our last discussion on the attack on this central problem of Physics. Progress would be much hastened if we could obtain in the laboratory powerful but controllable sources of high-speed atoms and high-frequency radiations to bombard matter. By the experiments of Tuve, Hofsted and Dahl, in the Department of Technical Magnetism, Washington, and by Cockcroft and Walton in the Cavendish Laboratory, it has been found possible by the use of high potentials to produce a stream of protons artificially with an individual energy of about 1 million electron volts and to examine their properties. A number of other methods of producing high-speed atoms are under trial by other investigators, and there is a hopeful prospect that we may be able in the near future to obtain useful sources of high speed atoms and high frequency radiation and thereby to extend our knowledge of the structure of the nucleus.

Dr. J. Chadwick, F.R.S.: Experiments in which elements are bombarded by α-particles yield information about the structure of the atomic nuclei in different ways. From the anomalous scattering of the α-particles an estimate of the dimensions of the nucleus and of the height of the potential barrier can be obtained. The disintegration of the nucleus with the emission of a proton gives information about the energy levels of the α-particles and protons of which the nucleus is composed. From some elements γ-radiations are emitted which can be connected with the disintegration. In the cases of beryllium and boron, it seems probable that a new type of disintegration occurs in which a neutral particle of mass 1 is released instead of a proton. The collisions of these "neutrons" with atomic nuclei are being investigated, and in nitrogen disintegrations of the nucleus have been observed. The neutrons thus provide a new tool for the investigation of nuclear structure.

Dr. C. D. Ellis, F.R.S.: A combination of evidence from different sides has suggested that the γ-rays emitted from radioactive nuclei are intimately connected with the α-particle stationary states. The evidence

on which this conclusion is based will be briefly reviewed and an attempt made to distinguish between those steps in the argument which can be proved and those which must be assumed as reasonable. An important result of this view is that it stimulates and gives point to work on β-ray spectra which at present provides the only accurate and reliable information about the γ-rays. The details of the nuclear α-particle states are shown directly in the γ-ray spectra and the importance of increasing the extent and accuracy of our knowledge will be stressed. The present position of the experimental methods and of the way in which these are being developed will be briefly discussed.

PROFESSOR J. C. McLENNAN, F.R.S.: Data derivable from a study of the fine structure of the spectral lines of a number of the elements are now available and these enable us to evaluate the magnetic moments of certain atomic nuclei. Also the "g" values (ratio of magnetic to mechanical moment) can be determined. The evidence furnished by these results would appear to show that in some cases at least the mechanical moments of atomic nuclei cannot originate solely in the spin of one or more of the protons within these nuclei. To account for the results it has been proposed that some at least of the protons within nuclei should be considered to be endowed with quantised orbital motions similar to those of the extra nuclear electrons of atoms. The results of efforts to make progress in this direction will be briefly summarised.

N. F. MOTT: From the number of particles scattered when a beam of α-particles passes through a given substance, one may draw conclusions about the law of force between an α-particle and a nucleus. If the law of force is that of the inverse square, both classical and quantum mechanics predict in general the same scattering formulæ, namely (for heavy nuclei) the Rutherford law. The fact that this formula is in agreement with the experiment for heavy nuclei, provides the most direct evidence that we have that the inverse square law is valid between two nuclei for large distances.

So long as the inverse square law of force is assumed, the only case in which classical and quantum mechanics lead to different results is that of the scattering of α-particles by helium. The scattered α-particle and the knocked-on helium nucleus are then indistinguishable. The application of quantum mechanics to a problem of this type, involving the interaction of two similar particles, cannot be made unless one knows whether the particles have spin and whether they obey the Einstein-Bose or the Fermi-Dirac statistics.

The fact that the odd rotational states are missing in the band spectrum of He_2 shows that α-particles have no spin and that they obey the Einstein-Bose statistics. One may then apply quantum mechanics to the problem; the most striking result is that the number of particles scattered through 45° is double that to be expected on the classical theory, for all energies of the α-particles. The effect has been observed by Chadwick, and by Blackett and Champion, for slow α-particles; for fast particles the assumption of the inverse square law field is not sufficient.

For fast α-particles and light nuclei further deviations from the classical scattering formulæ occur. In order to explain these deviations, one may assume that potential energy $V(r)$ of an α-particle at a distance r from a nucleus is given by the inverse square law form $2Z\epsilon^2/r$ up to a distance r_0, but has another form for r less than r_0. Wave-mechanics may be applied to calculate the scattering by such a field. The following are the main features of the scattering to be expected:—

If the "classical" distance of closest approach for a head-on collision, namely $2Z\epsilon^2/E$, where E is the energy of the α-particle, is greater than r_0, the deviations from classical scattering will be small. If, however, this distance is less than r_0, there may be considerable deviations even at angles for which the classical distance of closest approach is greater than r_0. The best estimate of r_0, the radius of the nucleus, is therefore to be obtained from the energy at which anomalous scattering begins at a large angle.

For suitable forms of $V(r)$ resonance levels may exist. That is to say, there will be ranges of energy, for which the α-particle can enter quite easily into the nucleus,

although the classical distance of closest approach is greater than r_0. For such ranges of energy one would expect anomalous scattering and artificial disintegration to take place.

For the lightest nuclei, hydrogen and helium, the scattering deduced from wave-mechanics is expressed by a particularly simple formula. If one assumes that r_0 is less than about 4×10^{-13} cm., then the form of the field for r less than r_0 affects only a single parameter in the formula, which is a function of the energy but not of the angle. That there is fair agreement between experiment and this formula has been shown by Taylor. Taylor has also made an estimate of the form of $V(r)$, both for two α-particles, and an α-particle and a proton, for r less than r_0.

Professor R. H. Fowler, F.R.S.: There are two main lines of evidence which tell us more or less unambiguously what must be the value of the nuclear spin. These are fairly familiar and can be shortly recapitulated. The first and best is the evidence of alternating intensities in the band spectra of diatomic molecules in which the two atoms are identical—for example, the molecule $H - H$, $N_{14} - N_{14}$ or $O_{16} - O_{16}$ (but not $O_{16} - O_{17}$, etc.). Linear molecules such as acetylene $H - C_{12} \equiv C_{12} - H$ also yield evidence of the same type, but of course we get nothing new here, only further evidence for the spin of the proton. If the spin of the nuclei in such molecules is $n(h/2\pi)$ then the intensities of the band lines alternate in the ratio $(n + 1)/n$. We find in this way with certainty that the following spins (the list is not exhaustive):—
H $\frac{1}{2}$; He = O; N_{14} 1; C_{12} ≡ O; O_{16} O.

We find, too, in this way the most unambiguous evidence for the type of statistics satisfied by the nuclei in particular that N_{14} has the Einstein-Bose statistics which forces us (along with other evidence) to the deep and disturbing conclusion that the electrons in the nucleus no longer contribute to the spin on the statistical type.

The second main type of evidence is from the details of the hyperfine structure of atomic spectra. Here we are concerned with all the pertubation which a nucleus can exert on the optical spectrum, and it is not always easy to separate spin effects from others such as isotope effects, which must all be observed together. Nevertheless, it has been possible, especially by the use of the Leeman effect as modified by the Paschen-Bash, for the hyperfine structure to determine the spin with certainty for some atomic species, notably Bi, 9/2. This determination uses only qualitative evidence. By using quantitative evidence from the width of the hyperfine structure one ought to be able to determine the magnitude of the nuclear *magnetic moment* associated with the nuclear spin. It has been shown in this way that nuclear magnetic moments are of the order of the *protonic Bohr magneton, i.e.*, of the order of 1/2000 the ordinary Bohr magneton. But there are still great difficulties in a more exact determination.

A subsidiary line of spectroscopic evidence, which may prove very useful in future, is derived from a study of the depolarisation of resonance radiation in the manner of Collett.

While these are the main ways in which the nuclear spin must be determined they are not closely relevant to radioactive nuclei, and we have at present little hope of a direct determination for such nuclei by optical methods. But the spin may none the less be very relevant, as has been shown recently by Gamow in a letter to *Nature.** He there compares the regular sequences of radii for the uranium-radium and thorium families of radioactive elements, calculated from his theory from the observed rates of decay, with the irregular radii deduced for the actinium series. He suggests that this may be due to changes of spin of the nuclei of the actinium series. If the spin changes the α-particle must carry away the corresponding angular momentum, and the formula for the life of the nucleus is modified. The observed irregularities are accounted for if changes of the order of 3 units of spin can occur in the actinium series (atomic weights $4n + 3$), whereas they do not occur in the other series (weights $4n$ and $4n + 2$). This seems quite possible, but of course is purely speculative at present.

* 'Nature,' vol. 129, p. 470 (1932).

THE DISINTEGRATION OF THE ATOM.

From the Cavendish Laboratory at Cambridge, is announced the fact that Drs. J. D. Cockroft and E. T. S. Walton, working under the direction of Lord Rutherford of Nelson, have achieved disintegration of the atom at a voltage of only 120,000. For some time past American and German physicists have been working with voltages as high as 10,000,000.

In connection with the Laboratories' most recent achievement, Lord Rutherford told the press that "Science is on the eve, perhaps, of a great discovery in connection with the structure of matter."

At the moment, the discovery is more of academic interest rather than of practical application but the step is one of great moment.

Dr. Cockroft told the press that we may learn how elements have been built up, if only sufficiently large enough voltages can be utilised.

The Cavendish Laboratory has much to be proud of in its achievement, following so closely as it does on the announcement of Dr. Chadwick's work on the neutron.

From the information available it appears that disintegration was accomplished by means of a vacuum tube through which millions of particles a second were fired at a speed of 10,000 kilometres per second. The atom, has of course, been split before, but in this particular instance energies were procured from atoms as they broke up 100 times greater than that of the particles by which they were attacked. Another discovery arising out of the above experiment was that some of the hydrogen atoms as they were bombarded, broke into helium.

In May 1931, Lord Rutherford communicated a paper to the Royal Society describing the use of thyratrons, and in the recent experiment this device was utilised in counting at high speed physical phenomena. The drawback of using a mechanical relay and a counting meter, in conjunction with a valve amplifier, for counting physical events which are repeated very rapidly is that a small but finite time is required by the armatures to move to and fro in the process of counting, and, therefore, if a second particle arrives before the recording of the first has been completed, it will be missed.

The use of thyratron valves removes this difficulty. These valves have negligible inertia and no moving parts, and there is not the small time lag which occurs in any mechanical relay. The use of this device is typical of the progress in physical science.

FARADAY MEDAL FOR SIR OLIVER LODGE.

In recognition of his distinguished services towards the advancement of science, the Faraday Medal was presented to Sir Oliver Lodge at the Institution of Electrical Engineers on 22 April.

"I suppose this is the last medal I am likely to receive," said Sir Oliver, as he accepted the award. He said he and the institution had practically grown up together.

"I remember hearing Graham Bell come over with the first telephone and describe it," he said. "I remember the enthusiasm and scepticism is aroused, for there were sceptics in those days about the telephone.

"But then there are sceptics about everything. (Laughter.) The word sceptic properly means one who looks into a thing, and I have no objection to that kind of scepticism."

ROYAL INSTITUTION EXHIBITION OF X-RAY CRYSTAL ANALYSIS AND ITS VARIOUS APPLICATIONS.

The Managers of the Royal Institution invite all members of scientific societies or senior students of universities and technical institutions, and others interested in this work, to this Exhibition at the Royal Institution, 21, Albemarle Street, W. 1, at any time between 10 a.m. and 6 p.m. on Monday, May 9, or Tuesday, May 10. The Managers would be glad if such visitors would leave their names and addresses.

NEW INSECTICIDE ANNOUNCED BY THE U.S. DEPARTMENT OF AGRICULTURE. RETENONE.

We have received intimation from the U.S. Bureau of Soils, some details of the Chemical structure of the new insecticide, Retenone. Dr. C. A. Browne of the Bureau hopes that Rotenone can be developed ultimately into the insecticide most nearly approaching the ideal.

With a knowledge of the structure of rotenone and associated compounds, said Dr. Browne, it will be possible to attempt to synthesize rotenone as a chemical product instead of being forced to extract it from vegetable sources. This new knowledge may also permit the synthesis of other compounds of analogeous make-up which are likely to possess valuable insecticidal properties.

"Chemists of the Bureau have been in competition with some of the best chemists in Japan and Germany," says Dr. Browne. "By solving this difficult problem ahead of those who started many years earlier, our chemists have earned credit for one of the most brilliant chemical achievements of the Department.

Dr. F. B. LaForge, Dr. H. L. Haller and L. E. Smith were named by Dr Browne as the scientists who accomplished this discovery. It is expected that further investigations will result in the production of insecticides which will be more effective in checking the ravages of insect pests which cause tremendous losses each year in this country.

Rotenone is a white crystalline material, and is both a contact insecticide and a stomach poison. It is more poisonous to aphids (soft-bodied plant lice) than is pure nicotine. It is also poisonous to fish and other cold-blooded animals, but appears to have no effect on humans and warm-blooded animals, a property which adds greatly to its usefulness.

It can be obtained from the roots of Derris elliptica, an East Indian plant, and also from the roots of Lonchoarpus nicou or cube (pronounced coo-bay) from South America. This species of derris is a vine, and is a member of the pea family. Cube is a shrub-like plant resembling a small common locust tree.

NEW LIQUID RESIN: ABALYN.

Development of a new liquid resin to be known under the name of Abalyn is announced by the Naval Stores Department of the Hercules Powder Company. The new product is a resinous plasticizer for nitrocellulose lacquers and other products. The properties of Abalyn indicate that it will find a wide application in the manufacture of such products as clear interior lacquers for metal and wood, alkali-proof lacquers, leather lacquers, coatings for fabric and paper, non-drying inks, rubber cements, adhesives, water-proofing compositions, transparent paper and similar products.

The new liquid resin, which was developed at the Hercules Research and Experimental Laboratories, has already been given many practical field tests and will be marketed from the Wilmington office of the Hercules Powder Company.

Abalyn is a pale yellow viscous resin that has a solvent action on nitrocellulose in the presence of alcohols. It has in addition, according to reports from the Hercules Naval Stores Department, the following properties.

It is not appreciably affected by alkalies or weak acids and does not hydrolyze with boiling water.

It has a faint, mild and ester-like odour.

It is compatible with all the normal non-volatile and volatile ingredients of nitrocellulose lacquers.

It is insoluble in water and is an excellent waterproofing and impregnating agent.

It is a substantially non-drying product although it oxidizes very slowly to a pale yellow resin.

It has a solvent action on practically all natural and synthetic resins, rubber, and drying oils.

It is not corrosive and does not liver with basic pigments.

It serves as both resin and plasticizer and may be used to impart gloss, adhesion and body in nitrocellulose lacquers, that normally contain no resins, without loss of flexibility.

RUSSIA PUSHES MANUFACTURE OF SODIUM FLUORIDE.

Commencement of the manufacture of sodium fluoride in Russia was made in the year 1927-28 by the Polewsky Chemical Factory in the Urals. The acid process was employed, and it is only recently that the many technical difficulties met with have been overcome. It is intended now to make considerable extensions in this manufacture, as the value of sodium fluoride, both as a wood preservative and as an insecticide, is highly placed by the Soviet. For 1932 the amount planned to be made is 7,850 tons, and by 1934 23,750 tons. The capacity of the Polewsky plant referred to above is being doubled, whilst a large new sodium-fluoride factory is now being erected at Katalinsk in the Urals. It is not anticipated that, even if the plant materializes, there will be any surplus of Russian sodium fluoride for the export market before, at any rate, 1935 or 1936.

GERMAN-POLISH POTASH PRODUCERS IN JOINT AGREEMENT.

The Polish Government approved on March 17, a commercial agreement between German and Polish potash producers. The agreement is for five years and by its terms the Polish organization Tesp (Society for the Exploitation of Potassium Salts) will receive a quota of 4 per cent. in the world market which is now dominated by the Franco-German interests. The German Potash Syndicate will control Polish production but will relinquish competition on the Polish market. Poland was formerly one of the best export markets for German potash ranking after the United States and Netherlands. In order to encourage the domestic industry Poland placed a tariff on potash imports and as a result German sales on the Polish market fell from over 100,000 metric tons in 1929 to less than 2,000 tons in 1931. It is said that the tariff forced the Polish agriculturists to purchase unrefined domestic salts in place of the concentrated refined product to which they were accustomed. While the possibility of a loan to the Polish industry by the German syndicate was discussed it appears that the sales agreement does not provide for any financial assistance to the Polish industry.

SODA ALKALI EXPORTS FROM GERMANY.

German exports of caustic soda during recent years ranged between 11,000 and 15,000 metric tons and sodium carbonates between 53,000 and 75,000 tons. Approximate figures covering this trade in 1913 in comparison with the last five years are as follows:

	Caustic soda	Sodium carbonates
	Metric tons	
1913	13,000	66,800
1927	11,300	52,800
1928	15,900	53,800
1929	14,000	60,300
1930	13,200	74,900
1931	14,700	61,100

KAURI GUM RESEARCH AT NEW ZEALAND.

The Department of Scientific and Industrial Research, which has been carrying on experiments at the request of the Kauri Gum Control Board, reports that tests in connection with a process for the extraction from kauri gum chips of a material suitable for use in nitrocellulose lacquers have shown good results, and, subject to finance being available, the work will be continued.

BAY OIL IMPORTS FROM PORTO RICO INCREASED.

Porto Rico, while supplying bay oil in relatively small quantities, expanded its sales to the United States during 1931, having been the origin of 16,300 pounds valued at $26,300, as against 13,300 pounds worth $22,400 in 1930.

SOME FERTILIZER EXPERIMENTS IN ONTARIO.

In a report on a number of experiments conducted by the Department of Chemistry, Ontario Agricultural College, it is pointed out that, as the result of investigation and experience thereby gained, ranges of fertilizer analyses to different classes of soils and groups of crops have, to a certain extent, been obtained. In 1929, says Mr. H. G. Bell, F.S.A., Associate Professor of Extension, the Department of Chemistry laid out, and has conducted since, a co-operative demonstration scheme whereby tests were made, not at the College nor on station farms, but on the farmer's own soils and under his own conditions. In three years (1929, 1930 and 1931) altogether 620 experiments totalling 2,373 plots were conducted.

In co-operation with a representative of the Ontario Agricultural College, suitable farms in the various counties where the demonstrations were laid down were selected. The fertilizer brands or mixtures used in this work were supplied to the farmer by the College, in unprinted bags and under the College tag, which gave information concerning the analysis. Plots of definite size were staked out by the fieldmen of the Department, and the application of the fertilizer was supervised. The co-operating farmers sowed their seed or planted their crop according to their usual custom, the fieldmen visiting the demonstrations once or twice during the growing season. In many localities the work became of such interest that the farmers asked for field meetings to be organized on a week-day evening, when other farmers of the neighbourhood might gather at the plots.

When possible the agricultural representative and a representative of the Department of Chemistry attended the meeting and discussed all points appertaining to the tests. Usually, signs were erected showing the location of the tests, and stakes were marked so that farmers could observe the progress being made throughout the growing season. At harvest time the fieldmen of the Department, in co-operation with the farmer, and, when possible, the agricultural representative, picked out typical areas of the plots. As regards grain and hay, square rod areas were harvested by hand; and in the case of hay, root crops and the like, weights were taken on the field.

Interesting Results.

The results of 1931, averages of three years, in turnip tests, which were conducted with fertilizers 2-12-6 and 0-14-6 on 15 farms, or 56 plots, showed, apparently, that the response was greatest on loam soils with light soils second best. The average gain by the use of fertilizers was 3.6 tons per acre.

In the case of alfalfa, tests were conducted on 20 farms, or 69 plots. These clearly indicated that two types of fertilizers gave the best returns, viz., 0-12-15 and 2-12-6. The fertilizers were applied broadcast on top of the alfalfa early in the spring. The largest returns were obtained on relatively light soils with loamy soils in second place. On clay soils the results were still noticeable although not so profitable. Phosphates and potash, as might be expected, gave the best results on legumes. The average gain by the use of fertilizers was 4,389 pounds an acre (green).

Meadow tests were conducted on six farms, with a total of 22 plots, fertilizers being applied broadcast early in the spring. Fertilizers 4-8-6, 2-12-6 and 0-12-15 were used and it would appear from the results that a fairly generous application of high nitrogen fertilizer gives profitable returns on meadows containing a considerable amount of grass. The average gain by the use of fertilizers was 4,315 pounds an acre (green).

Pasture tests were conducted on 10 farms, with a total of 27 plots. It was a difficult matter to determine the gains, and two farmers took the trouble of dividing off their fields used for the demonstrations with fences. Records were kept of the pasture days in one instance, and relative pasture yields in the other. Tests on one farm showed an average check yield of 2,800 pounds of grass. Sections of the pasture that re-

ceived nitrate of soda gave an average yield of 7,520 pounds. On the other farm, on heavy, sandy loam, it was found that on eight acres of fertilized pasture, compared with check receiving no fertilizer, the farmer got double the pasture days by the application of three bags an acre of a 3-10-5 fertilizer.

Wheat, Oats, Barley.

Tests with fall wheat were conducted on 27 farms, with a total of 94 plots, the most effective application being made through the fertilizer compartment of a combined drill. When fertilizer was applied broadcast on top of the soil and harrowed in, it did not give nearly the result obtained from the same amount drilled in to the soil. Summarizing the wheat results in accordance with soil types on which the wheat was grown, it is apparent that on the heavy soils where a number of tests were conducted, the largest net results were obtained from 0-12-5. All these tests were made on soils rich enough in nitrogen to produce a good crop, but in poor soils it was found profitable to use a fertilizer of a 3-10-5 or 2-12-6 type. The average gain from the use of fertilizers on wheat, average two years, was 9.9 bushels an acre.

Tests with oats were conducted on 12 farms, with a total of 34 plots. The fertilizer was used at the rate of from 250 pounds to 375 pounds an acre, 0-14-6 and 2-12-6 being chosen. On clay soil the average check plot yield was 33.5 bushels an acre. The use of 0-14-6 gave an increase of 10 bushels an acre, which was slightly better than the yield from 2-12-6. On loam soils the reverse was the case, 2-12-6 gave an increase of 17 bushels an acre. The average gain from fertilizers on oats, average three years, was 10.1 bushels an acre.

Barley tests were conducted on 12 farms, with a total of 35 plots, and in nine tests on clay soil 2-12-6 fertilizer gave the best result, yielding 33.5 bushels an acre. Next came fertilizer 0-14-6 with 33.2 bushels an acre, practically the same. Check plots averaged 23 bushels to the acre, leaving a gain of 10 bushels from fertilizing. The average over three years was 8.1 bushels.

Ensilage corn tests were conducted on 10 farms, with 35 plots, the average gain over three years being 4.68 tons to the acre. It is pointed out, however, in the report under review, that the manner of application of fertilizer to corn is one of supreme importance. While it is desirable to get the fertilizer sufficiently near to the seed for the maximum benefit, care must be taken that the seed corn does not drop immediately on top of the fertilizer. Should this happen the vitality of the young plant will be injured. Many farmers are finding it good practice before sowing the corn to drill in the fertilizer just as they would if they were applying it to small grain. The rapid and wide growing roots of the corn plant apparently make good use of such fertilizer.

Sugar Beets.

Sugar beet tests were conducted on five farms, with a total of 32 plots, on two types of soil. The indications were that on light soils the use of 2-12-6 fertilizer plus potash gave the highest tonnage. Fertilizer 4-12-12 came second, with the highest percentage of sugar, while on clay soil 4-12-12 gave the highest tonnage. The average gain from all fertilizers on sugar beets over three years was 3.25 tons an acre.

The foregoing experiments are but a few of those that could be quoted, but they are sufficient to illustrate the results that have been obtained, besides demonstrating the response of crops to fertilizer when properly applied. The suitability of the fertilizer will depend entirely upon the choice of analyses suited to the needs of the crop with which they are to be used, and at the same time are suited to supplement the natural fertility of the soil to which they are to be applied, and the manure that has already been used. If these precautions are observed, and the fertilizers applied with proper care, it is stated that, under normal conditions, they return a good profit to the user.

It must be borne in mind, however, that the particular experiments quoted apply only to soils in the localities in which the

tests were actually conducted. No hard and fast rules can be laid down. What applies to one part of Canada does not necessarily apply to another; neither can it be said that results from one part of Ontario—or any other province, for that matter—can be repeated in another. Local conditions must be studied and known.

ALCOHOL FROM SAWDUST.

A description of the Scholler-Tornesch Process in operation in Holstein, Germany (*contributed by a foreign correspondent of "Chemicals," of New York, by arrangement*).

The Scholler-Tornesch process for utilizing wood cellulose as a raw material for alcohol manufacture has been operated upon a commercial scale since the latter part of 1931, at the alcohol plant of the Brennerei und Presshefe-Fabrik Tornesch G.m.-b.H., Tornesch, Holstein. A subsidiary corporation, the Deutsche Holzverzuckerungs und Chemische Fabrik, A. G., was recently formed to acquire the patents and rights to the invention.

The Tornesch plant has in operation three digesters with a capacity of 6 metric tons of sawdust each. Two additional digesters with a capacity of 12 tons are now being erected. The Scholler process is being continuously operated, on a basis of three eight-hour shifts, and employs twenty-six workmen at the present time.

General Description of the Invention.

While any kind of wood or cellulose material such as maize, or rice hulls may be employed, the present commercial working of the Scholler process is based upon the use of cheap waste materials from lumber mills, such as sawdust, shavings and wood chips. Various species of woods give different yields, the common German "kiefer" (pine) waste now being used. One hundred kilos of dry wood is said to produce 60 kilos of glucose, the conversion requiring from 8 to 10 hours.

Advantages Claimed Over Other Processes.

Certain advantages are claimed for the new process over previous methods for manufacturing glucose from wood. Previous processes, it is asserted, utilized dilute acids with a maximum yield of 9 litres per 100 kilograms of wood which Dr. Scholler states is commercially unprofitable. Processes employing concentrated acids had to recover these substances for which purpose expensive apparatus was necessary. The Scholler-Tornesch method is said to require only one part per thousand of hydrochloric or sulphuric acid which is not necessarily recovered and the use of ordinary iron digesters further reduces costs. It is essential, however, to have the plant erected near the source of waste material.

Products of the Process.

The following products obtained from 100 kilograms of dried wood by the Scholler-Tornesch process.

Usable glucose	40 Kilos
Waste glucose	20 Kilos
Lignin	33 Kilos
Weak acetic acid	4 Kilos
Furfurol	1 Kilo
Ethyl di-bromide ...	0.2 Kilo
Unknown	1.8 Kilo

The present production costs of the Brennerei und Presshefe-Fabrik Tornesch are stated to be 0.11 marks a litre (1 mark equals $0.238. 1 litre equals 1.057 quarters), based on a 25 litres production from 100 kilos of wood. Wood costs at Tornesch amount to 17 marks per metric ton or 0.07 marks a litre for raw material, making a total cost of 0.18 marks per litre. In actual practice, costs have varied from a minimum of 0.14 marks to a maximum of 0.18 marks per litre.

The estimated cost of erecting an entirely new plant capable of turning out 35,000 hectolitres of alcohol (1 hectolitre equals 26.418 gallons) annually would amount in Germany to about 900,000 marks. The actual cost of the Tornesch plant was only 300,000 marks as the equipment for converting the glucose into alcohol was already available.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.
May 5, 1932.

The following papers were read.

A Closer Analysis of the Heat Production of Nerve. A. V. HILL, F.R.S.

The heat production of nerve is believed to occur in two phases, "initial" and "recovery": the former is presumably an accompaniment of the physical and chemical changes which take place during the propagation of the impulse; the latter, of the processes by which those changes are reversed and the nerve restored to its initial state.

It is not easy to separate the one from the other; indeed, during the earlier part of this research it was realized that in a strict sense, and on the evidence available, there might really be no "initial" heat at all. The possibility that the initial heat is due to phosphagen breakdown or lactic acid formation is discussed: the quantities available are sufficient.

The Influence of Coloured Surrounds and Coloured Backgrounds on Visual Thresholds. H. E. ROAF. Communicated by Sir Charles Sherrington, F.R.S.

Exposure of the retina to light raises the differential threshold. This increase in threshold may be due to direct action of light on the same retinal area, to some interaction between different parts of the same retina or to some interference due to central connections of the two retinæ.

These three possibilities have been investigated. It was found that for the fovea the chief influence in raising the threshold is the simultaneous exposure to light, and for the parts of the retina outside the fovea there is considerable spread of effect from one part of the retina to another.

The influence of wave length on the results is very striking with foveal vision, as "red" light raises the threshold for all parts of the spectrum but "green" and "blue" lights have a negligible effect on the long wave length end of the spectrum.

Carbohydrate Metabolism in birds. The site of the Biochemical lesion in avian polyneuritis. By N. GAVRILESCU, A. P. MEIKLEJOHN, R. PASSMORE and R. A. PETERS. Communicated by Sir Charles Sherringham, F.R.S.

We have compared the oxygen uptakes of normal and avitaminous brains in the presence of these three substrates, succinate being regarded as typical of another system. Since cyanide inhibits the uptake of oxygen for all three substrates, any difference in their behaviour in avitaminosis indicates that the vitamin acts specifically and not upon the indophenol oxidase. Our results show that a tissue may behave normally to succinate and yet abnormally to lactate, and are therefore consistent with the view that vitamin B_1 deficiency is connected essentially with the intermediary metabolism of carbohydrate.

The following papers were read in title only:—

Central Nerve Terminals in the Mammalian Spinal Cord and their Examination by Experimental Degeneration. By E. C. HOFF. Communicated by Sir Charles Sherrington, F.R.S.

The Genus Hyracotherium. A revision and description of new specimens found in England. By C. FORESTER COOPER. Communicated by D. M. S. Watson, F.R.S.

Notices of Books.

Thermodynamics by PROF. A. W. PORTER, F.R.S., with a General Preface by PROF. O. W. RICHARDSON, pp. viii + 96. London: Methuen & Co., Essex Street, W.C., 1931. Price 2s. 6d.

Prof. Porter's short Monograph on *Thermodynamics* forms one of Messrs. Methuen's useful half-crown series on Physical Subjects. The author has aimed at presenting a concise outline of the subject so that the reader, and especially the student, will be able to understand readily the logical foundations of thermodynamics and will see the kinds of applications that are made of thermodynamical principles and also be able to apply them himself to further problems.

The book is composed of chapters on the Beginnings of Mechanics, Carnot and Caloric, the Laws of Thermodynamics, Reversible Changes, Applications *e.g.,* the Joule-Thomson Effect). Irreversible Operations and Equilibria, etc. The text is not overburdened with details of applications and forms a handy and useful volume for the student.

In his preface Prof. Richardson commends the book and the series to students of Physics and

others desirous of becoming acquainted with the essentials of the modern developments covered by the series. Among the other volumes are monographs upon *Spectra* by Dr. R. C. Johnson, *Wave Mechanics* by Dr. H. T. Flint, *Conduction of Electricity through Gases* by Dr. E. K. Emeléus, *Magnetism* by Dr. E. C. Stoner, *X-rays* by Dr. B. L. Worsnop and *Photochemistry* by Dr. D. W. G. Style, whilst others are in preparation.

They should all commend themselves to a wide circle of readers.

Forthcoming Events.

FRIDAY, MAY 6, and SATURDAY, MAY 7.

S.C.I. EDINBURGH AND EAST OF SCOTLAND AND GLASGOW SECTIONS. *Joint Meeting with the Scottish Section of the Institute of Chemistry.* 3.45 for 4 p.m. Reception by Principal Sir James Irvine, F.R.S., at St. Salvator's Hall, The University, St. Andrews, at 5 p.m. "Alchemical Literature and Iconography," by Prof. J. Read. 7.30 p.m. Informal Dinner at Rusack's Marine Hotel. Tickets 7s. MAY 7.—10.15 a.m. Assemble at Chemistry Department. Short illustrated talk by Prof. Read on St. Andrews.

INSTITUTE OF CHEMISTRY. *Scottish Section.* Joint meeting with the S.C.I. (See above.)

MONDAY, MAY 9.

BRITISH ASSOCIATION OF CHEMISTS. *Notts and Derby Section.* King's Café, Derby, at 7.15 p.m. "The Organisation of the Profession," by A. W. Knapp.

TUESDAY, MAY 10.

BRITISH ASSOCIATION OF CHEMISTS. *Birmingham Section.* Annual Meeting. Chamber of Commerce, New Street, Birmingham, at 7.30 p.m.

ROYAL PHOTOGRAPHIC SOCIETY. *Scientific and Technical Group.* 35, Russell Square, W.C. 1, at 7 p.m. "Meteorology of Gas Explosions," by O. C. de C. Ellis. Demonstration of: "A Minute Thorium Light." "A Control Valve for Compressed Gas," by A. S. Newman.

INSTITUTION OF PETROLEUM TECHNOLOGISTS. *General Meeting.* Royal Society of Arts, Adelphi, W.C. 2, at 5.30 p.m.

WEDNESDAY, MAY 11.

INSTITUTE OF FUEL. Burlington House, Piccadilly, W. 1, at 6 p.m. "Artificial Formation of Bituminous Coal and Mineral Oil Hydrocarbons," by Prof. Dr. E. Berl. Members of the following Institutions have been invited:—S.C.I., Chemical Engineering Group, Chemical Society, and the Institute of Chemistry.

INSTITUTION OF ELECTRICAL ENGINEERS. *Tees-Side Sub-Centre.* Cleveland Technical Institute, Middlesbrough, at 7 p.m. Annual General Meeting. "An Analysis of the Costs of Electricity Supply and its Application in Relation to Various Types of Consumers," by E. H. E. Woodward and W. A. Carne.

INSTITUTE OF METALS. Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W. 1, at 8 p.m. Twenty-second Annual May Lecture on "Plastic Deformation of Metals," by Prof. Dr. F. Körber.

THURSDAY, MAY 12.

OIL AND COLOUR CHEMISTS' ASSOCIATION. *London Section.* Annual General Meeting. 30, Russell Square, W.C. 1, at 7.30 p.m. "Development of Government Intervention and its Effect on our Industry," by S. K. Thornley.

IRON AND STEEL INSTITUTE. Chamber of Commerce Buildings, Birmingham, at 6.30 p.m. "Fourth Report of the Committee on Heterogeneity of Steel Ingots." "Blast-Furnace Engineering," by W. R. Brown. "Some Experiments on the Nitrogen Hardening of Cast Iron," by J. E. Hurst. "Manganese-Silicon and Nickel-Silicon Cast Irons," by A. L. Norbury and E. Morgan.

FRIDAY, MAY 13.

BRITISH ASSOCIATION OF CHEMISTS. *London Section.* Annual General Meeting. Broad Street Station Restaurant, E.C., at 7 p.m.

New Patents.

These particulars of New Patents of interest to readers have been selected from the Official Journal of Patents and are published by permission of the Controller of H.M. Stationery Office, and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

Latest Patent Applications.

10,650.—Drugs Products Co., Inc., & Skerrett, H. N.—Producing bismuth sodium gluconate, etc. April 14.

10,762.—Fettsäure-und Glyzerin-Fabrik Ges.—Making sulphonated oleic acids, etc. April 14.

10,831.—I. G. Farbenindustrie Akt.-Ges., & Johnson, J. Y.—Manufacture of carbonic acid chloride. April 15.

Specification Published.

370,436.—Arundel, H., Davies, G. P., and Imperial Chemical Industries, Ltd.—Manufacture of picric acid.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, at the uniform price 1s. weekly.

363,526.—Lime.-Akt.-Ges. Fur Stickstoffdunger, Knapsuck, near Cologne, Germany.

Moulded calcium oxide is prepared by pressing substantially dry calcium oxide powder or calcium hydroxide powder without adding any binding agent. Thus 1,000 kilos. of anhydrous lime powder are calcined at a temperature of 500-1,000° C. and the 750 kilos. of pulverized calcium oxide thus obtained are moulded in an extrusion or hydraulic press under a pressure of 700-1,000 kilos. per sq. cm. at a temperature of 20-400° C. Alternatively the lime powder may be first pressed under a pressure of 700-1,200 kilos. per sq. cm. and then calcined in a shaft furnace.

THE CHEMICAL NEWS

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EDITORIAL

In this week's issue we publish the preliminary announcement of a sectional meeting of the World Power Conference to be held in Scandinavia in the summer of next year. Apart from the natural charm of the surroundings chosen as a venue for such meeting, all visitors and delegates should learn much of interest. We have repeatedly stressed in issues of the *Chemical News* during the past six months the need for greater and more expert study of the absorbing question of Power—in all fields.

Already man has wrested from nature large supplies of practically free power by harnessing water, but this supply is limited to those districts with abundant water. With the disintegration of the atom, announced last week from the Cavendish Laboratory, much wild talk has circulated as to the possibilities of free energy made available by such a discovery. The achievement of Dr. J. D. Cockroft and Dr. E. T. S. Walton, working under the renowned physicist, Lord Rutherford, is nothing short of marvellous, even in these enlightened days—but—much, very much work has yet to be carried out by workers in all the correlated fields of science, before we can get free energy. We know, that the harnessed atom, would mean unlimited power for mankind at little or no cost. Therefore the inference is—better living conditions for all. But, would such better conditions obtain or would the world (in the social sense) remain as static as it has after the full benefit of discoveries in chemistry have been showered upon it. The threat of chemical warfare sets one thinking. Bad as were the horrors of gas in the Great War, we know that any such method of warfare in any future campaign would be inconceivably worse.

Men of science, are, as a class, peace-loving, yet in time of national emergency one's emotions are apt to run away with one's intelligence. Despite our improved methods, brought about by scientific discovery, millions of people, of every nation, are literally in dire want and on the borderline of starvation. If any improved methods, brought about by any utility of the knowledge of the structure of matter, accentuates the conditions in living now existent, then it can only be that the intelligence of our people has increased beyond their capacity for sympathy and understanding. Fortunately the conditions now prevalent throughout the world, may have a few years in which to recover, as the recent atomic discoveries, are, at the moment of more academic interest than capable of practical application.

EXPOSURE TO SALT SPRAYS AS A TEST FOR METALS USED IN AIRCRAFT.

By H. W. Blood Ryan.

A paper read recently before the American Chemical Society by J. L. McLond of the Ford Motor Engineering Laboratory states that metals for use in aircraft construction are exposed to salt spray tests. These experiments are being carried out in order to find a really effective method to overcome corrosion, and the complete success will be awaited with great interest by chemists and metallurgists alike. The advent of the all-metal aeroplane has brought in its train new problems for the Chemist in protecting the surface of the aeroplane against decay. The metal aeroplanes are constructed largely of alloys, with some use of mixed construction, such as steel and aluminium alloys. The final choice of these metals is governed largely by what may be called, form. If the aeroplane part requires to be of a certain strength, and is large enough to have inherent stiffness, then steel is used, otherwise it will be of aluminium alloys.

Strong aluminium alloys have weight strength ratios equal to heat treated alloy steels and have excellent stiffness. With such materials, and bearing in mind that, with equal weight, that part is stiffest which has the greatest surface, the problem of corrosion prevention becomes paramount. Not only does design demand such a distribution of metal, but safety requires that it must not be overlooked.

Engineers, metallurgists and chemists investigating metals for use in aircraft construction, must subject them to the most severe conditions likely ever to be encountered by the aeroplane. That done, they must then prepare to overcome the effects of wear in ordinary service. Corrosion in metals starts from the surface and in a structure that is largely surface it must be prevented from ever starting.

A very cogent reason for this surface importance is the type of corrosion peculiar to light metal alloys, namely, inter-crystalline. Steel, by contrast, is affected mainly by pitting of the surface, but the light alloys become corroded along their grain boundaries, without necessarily becoming pitted.

This factor, obviously, makes it generally much more difficult to detect by observation only and the effect may be quite pronounced without being in any way appreciably visible.

Considering the effect of corrosion on the two types of metals, that on steel is to reduce its tensile strength and that on light alloys, to lower its elongation or extensibility.

In a recent test carried out in the Ford Laboratories and reported by Mr. McLond, a study was made of protective coatings over light metals, bars of thin duraluminium being exposed to corrosive conditions. The test pieces were coated as desired and then tied together with cord in groups, with half-inch wooden spacers between them.

These packages were placed in a salt spray box, so that they were in a horizontal position and edgewise, thus producing uniform corroding conditions.

The salt spray box was arranged in such a way as to ensure that the test pieces were continuously surrounded by a fog of spray from a 20 per cent. sodium chloride bath. Air blown into the box through a nozzle produced the conditions. As the pieces deteriorated in the corrosive atmosphere, repeated numbers of them were re-tested for the same tensile properties and these properties were plotted against time.

The experiment enabled the chemists to determine the protection value of the various coatings as well as the requirements of these coatings from the consumers' point of view.

The results of this test may be summarised as follows.

It is, of course, difficult to evaluate in terms of aeroplane service, since of necessity it varies so much. In a machine constructed of duraluminium, carrying out an ordinary overland service, no protection is necessary, save for the skin. But if a machine is engaged in the sea and coastal service, protection becomes, of necessity, in direct proportion to exposure to salt air and spray.

The consumers' requirements, are the actual protection of the metal from corrosion, measured not only by the visual defects in the coated metal, but by the physical property of the coated and exposed metal pieces of an alloy that may be corroded; the adherence of the coating with maximum elasticity, and surface appearance and its retention.

SULPHITE FAULTS AND SULPHUR DIOXIDE EFFECTS IN THEORY AND PRACTICE.

Some forms of faults due to sulphur dioxide are common and to be expected when the dyestuffs used are known to be of poor fastness to stoving. This lecture, however, dealt with apparently inexplicable faults arising from the action of sulphur dioxide or sulphites on dyestuffs normally regarded as fast to stoving.

A number of typical faults were shewn, and their history described. The difference between normal stoving practice or the colour maker's stoving test, and the conditions under which such faults occur is emphasized. This difference led to the work of A. T. King (Society of Dyers & Colourists 1928, *16*) who shewed that a large number of these faults were due to the formation of an additive compound of one dyestuff molecule with one molecule of sodium bisulphite, to yield an azo sulphite, and that this reaction took place most readily, somewhat on the alkaline side of $NaHSO_3$. This work was confirmed and extended later by Goodall (Ibid. 1928, *45*, 145) to a large number of commercial dyestuffs.

Methods of testing the susceptibility of dyestuffs to the formation of azo sulphite are briefly described and the chemical theory of the addition reaction explained.

A new physico-chemical theory of the azo sulphite formation reaction based on pH value is propounded and shewn to explain why the conditions of maximum reactivity are slightly on the alkaline side of $NaHSO_3$, and not, as would be expected from purely chemical considerations, with $NaHSO_3$, itself.

The production of faults by formation of azo sulphite is, however, only one aspect of the question, and a number of typical faults caused by complete destruction of the dyestuff were shewn. The effect produced possesses the character of complete reduction of the dyestuff, and can be reproduced by spotting with cold hydrosulphite solution. The inference that sulphites can reduce dyestuffs in a similar way to hydrosulphite is confirmed by a comprehensive resumé of the work of Engel in this field, and in the further work of A. T. King (E.P. 332,398, E.P. 335,645).

Whilst giving strong support to the hypothesis of complete reduction in the cold the existing literature does not afford convincing proof of it, as the experiments described are practically all carried out at relatively high temperatures. Experiments are described shewing that sulphite can cause complete reduction of dyestuffs in the cold to yield products similar to those obtained by hydrosulphite treatment. Further experiments made with a view to determining the relative proportion of SO_2 and NaOH or the pH value of sulphite solution which gave the maximum reactivity of this nature with some twenty commercial azo colours are described. The pH value for maximum reactivity was found to be dependent on the characteristic auxochromes in the dyestuff—thus for example a dyestuff containing as principal auxochrome a hydroxyl group possesses maximum reactivity on the alkaline side of $NaHSO_3$, whilst one possessing an amino group has a maximum on the acid side.

This behaviour agrees with the Spiegel-Engel view of the initial stages of bisulphite reactions as taking place with the dyestuff in the true azo, as distinct from the quinonoid, structure. It is indicated that the complete reduction effect of sulphites is not confined solely to azo colours.

Abstract of paper read by Mr. F. L. Goodall, M.Sc., *before the* West Riding Section of the Society of Dyers and Colourists and published in the May issue of the Journal of the Society.

WORLD POWER CONFERENCE

Sectional Meeting in Scandinavia, June/July, 1933

The Swedish National Committee of the World Power Conference, acting in agreement with the National Committees of Denmark, Finland and Norway, announce that a Sectional Meeting of the World Power Conference will be held in Scandinavia from 26th June to 10th July 1933.

The Conference will be devoted to a study of the power questions of Large-Scale Industry and of Transport. The Technical Sessions will take place in Stockholm.

In connection with the Conference it is planned to arrange lectures, inspections and tours in Denmark, Norway and Sweden as well as excursion to Finland will be arranged.

All countries, represented in the Organisation of the World Power Conference, are invited to take part in the 1933 Sectional Meeting, to offer through their National Committees reports for publication, and to appoint official delegates.

The Programme of the 1933 Sectional Meeting is to be concentrated on the

Energy Problems of Large-Scale Industry and of Transport.

Attention will primarily be devoted to fundamental engineering and economic problems rather than to questions of technical detail.

Special points of particular importance for different branches of industry will, however, be discussed at some of the Sessions.

In order to obtain a desirable concentration even the general discussions on industrial energy problems should refer only to those branches of industry which are very large power consumers.

The Programme of Discussion thus will contain the following main groups:

ENERGY PROBLEMS OF LARGE-SCALE INDUSTRY
- Energy Supply:
  - Power and Heat
- Special Energy Problems of certain Branches of Industry
- Electrical Heating
- Transmission and Adaptation of Motive Power for Industrial Machinery.

ENERGY PROBLEMS OF TRANSPORT
- Railways
- Marine Transport

In connection with the Sectional Meeting of the World Power Conference there will also be held the First Plenary Meeting of the International Commission of Large Dams.

Energy Supply of Large-Scale Industry: Power and Heat.

Among the many subjects in this vast field, attention should be focussed upon the question of how large industrial plants can meet their energy requirements in the most economical way.

A main point will be to investigate whether it is better for a large industry to have its own power stations or to purchase power from the general electric supply or, eventually, how to combine both systems.

Here the question arises whether it is most expedient for industrial consumers to purchase power for their base load and to provide for peak power at local plants, or *vice versa*. The co-operation of water power and thermal power in industrial plants also should be studied.

Great interest attaches to the advantages to be obtained by interchange of energy between local industrial power plants as well as between industrial and public power systems. Synchronous operation, increasingly common, involves many technical-economical problems which should receive attention in this connection.

Furthermore, the industrial energy system should be looked upon more broadly, as a combined heat and power supply. One group of rationalization themes bears upon the possibility of adjusting supply and demand by storing heat. Another bears upon the utilization of secondary and by-product fuel.

A main theme running all through this Section will be the economic importance of the load factor, applied both to the power supply and to the industrial plant as a whole.

Special Energy Problems of the steam heat consuming industries.

This section is primarily intended for special energy questions of the pulp and paper industries, such as cooking, drying and ventilation. Here belong also many special applications of principles in regard to power and heat combinations, etc., which may have been treated from a more general point of view in the previous section, such as the utilization of low grade heat in the steam cycle, the use of wood refuse and black liquor as fuel, etc.

Special Energy Problems of the Iron and Steel Industry.

To this group belong, for instance, combinations of metallurgical processes and power production by steam and gas motors, distance transmission of gas versus local gas production, methods for increasing the energy economy of furnaces for heating and melting. Certain special power problems also may be dealt with here, for instance, those arising from the load variations in steel rolling mills.

Electrical Heating.

This section of the programme embraces the utilization of electrical heat for melting, heating and other heat treatment of ferrous and non-ferrous metals.

It is not intended, however, to include subjects relating exclusively to electrochemical industries or electric blast furnaces, as it is felt that this would unduly widen the scope.

Transmission and Adaption of Motive Power for Industrial Machinery.

Many technical questions of great economic importance arise in the operation of the heavy mechanical driving gear of industry. The introduction of the individual electric motor drive, the use of synchronous motors, of speed-regulating devices, of gears, for instance, involve many interesting problems in regard to the adaptation of the motive power to the special requirements of machine tools, conveyors, etc.

Energy Problems of Transport.

Railways.

The question which at the present moment appear to be most vital in this section bear partly on the competition between electrification and the use of steam and Diesel locomotives for long-distance traffic, and partly on the competition between electric railway and bus transport for city and suburban needs.

Marine Transport.

Here the questions of motor versus steam propulsion, electric power transmission, etc., may be discussed with regard taken to the various requirements entailed both by fast traffic and by cheap freight traffic.

The fullest details are available on demand from the Secretary, World Power Conference, Lincoln's Inn Fields, London, W.C. 1.

GREAT BRITAIN'S HOPES OF THE 1933 SECTIONAL MEETING.

By D. N. Dunlop,

President, International Executive Council, World Power Conference.

In his invitation to me to contribute to the *World Power Bulletin*, Professor A. F. Enström wrote, "the time tempts more to pessimism than to optimism, but even if the financial world gets out of order, and perhaps *then* even more than otherwise, there is an obligation for rational people to go on with their work and do some rational thinking."

I agree with him and I welcome wholeheartedly the plans for the forthcoming Sectional Meeting of the World Power Conference—all the more in that it is an example, set by the Scandinavian countries, of international co-operation in face of the exceptional difficulties of the world situation.

Our Meetings have always received support and attention throughout the world. I hope that before this Sectional Meeting members will see that, in their various countries, the true significance of the World Power Conference will be emphasized—that every Meeting is a precedent set by the scientists and technologists of the world to show that international co-operation is a practical reality. Let us never forget the enthusiasm of the first Plenary Conference when German participation began an era of collaboration between nations lately in conflict.

The Sectional Meeting of 1933 will do more than carry out the technical pro-

gramme arranged for it: it will give a clear message to the whole world that the members of the World Power Conference look beyond the narrow frontiers of nationalism and economic rivalry to the time when a system of world economy will give us a far better medium in which to meet those difficulties that necessarily arise in every phase of human evolution.

I have little belief in the ability of politicians and bankers by themselves to solve the problems that at the present moment menace our civilization. I have no doubt that by 1933 the immediate problems which we are facing to-day will have changed their aspect. But I am certain that no real beginning to economic reconstruction can be made until the nations of the world embark on a rational policy for the organization of production and distribution.

It is my conviction that over the next ten years there will come the opportunity to make the World Power Conference of greater service to the world than any of us, at its beginning, realized.

The world needs practical vision—without that practical vision what we have already brought about in the way of technical and scientific co-operation may be swept away. Let us, as the need arises, strengthen our unity as men engaged in a common task.

The scientific and technical industries of the world are the result of the creative activity of men of all nations: it is on us that now falls the task of seeing that that activity is fully utilized.

I often think of that saying " The People that have no Vision perish." It is my fervent hope that the World Power Conference may be able to give the world that vision into the future which can alone dictate the true way of action in the present, just as the men who made possible the work in which we are all engaged gave the world its marvellous insight into the powers of nature.

THE VIEWS OF SWEDEN'S REPRESENTATIVE.

G. MALM.

Chairman, Svenska Nationalkommitten för Världkraftkonferenser.

In a modern community the power supply is one of the corner-stones of the economic administration and thereby also of the development of the community as a whole. The solution of the power question includes for each country a great complex of problems, but although conditions change very much from one country to another, the fundamental principles regarding technical economy, on which the right solution of all these problems is based, are of common interest to all countries.

To study internationally these fundamentals, which are extremely important for the whole world, is the great idea which has inspired the World Power Conferences.

At the Conferences in London and Berlin and at the Sectional Meetings in Bâle, London, Barcelona and Tokio it has also been shown that there is a gigantic scope for international work in this field, and a great amount of material has been brought together. It will be left to the third World Power Conference in U.S.A. to throw light upon the gradual progress along the whole front of development in the different countries.

The Sectional Meeting which the Scandinavian Countries prepare to hold in June 1933, with technical discussions in Stockholm, will deal with a limited number of problems of special importance during the crisis which the whole world is now suffering from.

The most important points of the Programme are *the power questions of large-scale industry.*

We have endeavoured to bring forth the main technical-economical and organization problems now of paramount importance all over the world, and trust that producers and consumers of power will meet in discussion and bring out their different points of view to mutual advantage. Industry has been working under high pressure during these last years in order to master the economic difficulties through improved or new methods. At the Conference this technical progress will be illustrated and discussed.

Furthermore the Programme will include the *power questions of transport,* both by land and by sea. On account of the keen competition between different means of traffic asserting itself in all modern countries, these questions will without doubt attract special attention.

We have learnt with pleasure that the International Commission on Large Dams of the World Power Conference will hold their first full Session at Stockholm in 1933 in connection with our Conference.

With a great deal of anxiety the inviting countries have seen how, during the preparations for this Conference the crisis which already started in 1930 has developed into one of outstanding severity. In many countries the crisis has led to the introduction of extraordinary protective measures. All this has tended to diminish the good understanding and to alienate the nations.

It is not easy to name a remedy capable of breaking up the frozen channels of trade. Many factors must here come into play. One of the most important aims must be to inject new life into the idea of international co-operation and to change that atmosphere of distrust, which is now disturbing the harmony, into one of confidence and understanding.

Experience in past years has shown that whenever representatives from all the countries of the world have gathered for World Power Conferences or Sectional Meetings, it has always been in the spirit of good fellowship and co-operation. The great common aim allies and brings them together.

I am convinced that the Sectional Meeting 1933 will be an important link in that work of uniting the nations which is absolutely necessary in order to bring life to pulsate sanely in the body of the world. For us technologists who are never allowed to be discouraged through momentary difficulties, but who must always look forward to our goal, the improvement of the living conditions of humanity, it must be a special incentive to be able to contribute to these endeavours at a time like this.

Here in Sweden we have special pleasure in thinking of the moment when we have the honour of greeting guests from all parts of the world on our own soil. Our conditions are of course small in comparison with those of the big nations, but our country has been endowed with great natural resources for the development of water-power and with plenty of raw material for the production of industrial goods. We therefore feel assured that we have much of interest to show and we have included suitable excursions and tours of study to our Programme. Our country with its varying aspects, sometimes smiling and fertile, sometimes barren and dreary, with its thousands of lakes and countless water courses, deserves to be visited, and we have great pleasure in being able to show it.

With all our heart and with outstretched hands we bid the representatives from all countries welcome to the Sectional Meeting in Stockholm 1933.

S. R. Angelo (Chairman, Danish Committee) speaks for Denmark.

It is my very pleasant duty on behalf of the Danish National Committee to extend a hearty welcome to all attending the 1933 Sectional Meeting.

The fact that Denmark is known to the rest of the world as a primarily farming country, raising high-class agricultural products which rank among the finest in the world, makes us doubly cherish the visit of a number of leading technologists to our country. They will, thus, have the opportunity of seeing that we also can boast of considerable achievement in the industrial as well as other technical fields.

The technical programme adopted for the Sectional Meeting is devoted to the power problems of heavy industry and of transport. In these fields Denmark is in a rather favourable position as she can show her guests a very advanced industrial development. Danish Diesel engines are well-known throughout the technical world, and it is not due to a mere chance that one half of the world's total production of Diesel-engined ships during the last few years have been equipped with Diesel engines of Danish type.

With regard to the adoption of the Diesel engine in railway traffic Denmark is also well advanced. In these fields, as well as in a number of other allied activities, we have many things to show those participating in the Sectional Meeting and we hope that this opportunity of making a closer aquaintance with Danish industry will prove to be of interest.

The Danish National Committee will do its best to arrange the final programme for the visit to Copenhagen with regard to present-day problems.

At the same time we are going to do everything in our power to make our guests feel at home and to enable them to spend some pleasant days in Copenhagen and its charming surroundings.

We cherish the hope that the Sectional Meeting in 1933 will be met with interest by our colleagues all over the world, and we bid everybody heartily welcome to a two days' visit in the capital of Denmark.

B. WUOLLE, Chairman of *Finland's Nationalkommitté för Världskraftkonferenser* speaks of FINLAND'S hopes.

For a world organisation as the World Power Conference it is undoubtedly useful to hold so-called Sectional Meetings with more limited and concentrated programmes between the principal Conferences. These Meetings may sometimes embrace also more far-reaching countries and the programmes will then touch upon their special power questions, through which the interest in the important work of the World Power Conference will increase all over the world. At the same time the participants in the work of the World Power Conference will have an occasion to study the working conditions in the different countries and their ways and means of solving their different power problems.

For these reasons the Stockholm Meeting—and I permit myself here to use this abbreviated name as the chief discussions will take place in Stockholm—has met with great interest in Finland, not only on account of the choice of subjects for the discussion, but in particular because the programme provides, for those interested, an opportunity of making an excursion to Finland.

The main subject of the Conference, viz., "the Power Questions of Large-Scale Industry and of Transport," contains essentially problems which are of great actuality also in our country and for our industry. In Finland, industry has hitherto in most cases solved its power questions by providing its own power stations, either for water or thermal power. Thus, these two types of power, for a long period, have developed side by side. At present (1930 Statistics) the water power installations amount to 268,000 kw. and the installations in thermal power stations to 265,000 kw., each group representing just about one half of the total sum, 533,000 kw.

But the general power systems have lately increased in importance, and so the relation between them and the self-producing industry is receiving an increasing amount of attention. Co-operation between industrial power plants and energy clearing within certain districts also belong to the questions of the day.

In our country special attention is devoted to the power problems of the wood, cellulose and paper industries, partly because these branches form our most important industries, partly because the development of steam engineering in Finland for some time has concentrated around the power questions involved in these industries. In this connection the question of utilizing waste fuel also takes an important place.

The planned excursion, i.e., the possibility of meeting some of the Conference members in Finland as visitors, is giving us great pleasure, although for very natural reasons, the time reserved for it, is very short. This has caused certain difficulties in organizing the trip. Thus, we must limit the excursion to the southern part of Finland, where about 75 per cent. of the industry is located.

Furthermore, we must assume that most of the visitors—and in particular those who desire to get a reasonably thorough idea of our conditions—make the greater part of the trip by air. For visitors, preferring to go by sea, special excursions will be arranged according to time and wishes.

Due to lack of space the writer has to desist from a more detailed description of our conditions, but hopes to be able to give this in a later bulletin.

In the name of the Finland National Committee of the World Power Conference, however, I have the pleasure, already on this occasion, to offer a hearty welcome to all members of the Sectional

Meeting and in particular to those taking part in the excursion to Finland.

The Norwegian Chairman discusses the immense water power conditions in Norway. O. ROGSTAD, *Chairman Den Norske Komite For Verdenskraftkonferanser.*

It was with great satisfaction that the Norwegian Committee of the World Power Conference received information of the International Executive Committee's decision to hold the 1933 Sectional Meeting in Scandinavia.

The Norwegian Committee desires to extend to all the participants a hearty welcome to this Meeting, at the same time expressing its appreciation of the honour of being able to receive as its guests in Norway some of the world's foremost experts on power problems.

It is a well-known fact that nature has given to Norway a wealth of water power which, judging by European conditions, must be considered as rather important. From the latest investigations the water power which can be utilised is estimated at about 9.2 mill. kw., available all the year round. Of this water power about 1¼ mill. kw. have been built out, 700,000 kw. being used for general distribution requirements and the remainder in large industrial enterprises. The installed capacity of all plants amounts to 1.75 mill. kw. The production in 1930, totalled about 9,200 mill. kw., of which 8,400 mill. kw. went to cover the requirements of the general public. It may be assumed that, at present, the consumption of electricity among the public is higher per inhabitant in Norway than in any other country.

Furthermore, the possibilities for developing water power at low cost has caused foreign industry to locate works in Norway to a large extent, considering the size of the country and the population. In such cases it is generally a question of using electricity for electrothermal and electrochemical processes and for the lumber-refining industry. When the Norwegian National Committee of the World Power Conference invites the participants to Norway, it is, therefore, with the hope of being able to offer our guests an interesting and instructive visit.

The intention is to arrange a series of excursions to important water power plants as well as to industrial enterprises.

On the first day in Norway there will be an inspection of the Borregaard pulp mill and power station at Sarpsborg. From there the excursion will continue along the largest river in Norway, the Glommen, with visits to several power stations there: Vamma (82,000 kw.), Kykkelsrud (33,000 kw.) and Mörkfoss-Solbergsfoss (64,000 kw.), returning to Oslo in the evening.

Next day a debate will be held, the subject to be some question of immediate interest regarding delivery of power to industry. In the evening the Norwegian Committee will hold a banquet.

The following day the participants will make a series of excursions to the large power plants at Rjukan and Nore.

Rjukan, together with some neighbouring falls on the same water course, supplies about 275,000 kw. to Norway's most important industry "Norsk Hydro Elektrisk Kvaelstofaktieselskap." Nore is owned by the Norwegian Government and has now an installation of 100,000 kw.

For those who so desire, the excursion may be extended to the large power plants in Western Norway, Sauda, Tysse, Bjölvo, Höyanger, etc., which with their large fall heights and great capacity have much of interest to offer both to the layman and to the expert.

The Norwegian Committee hopes and believes that the visit will be both of pleasure and of profit to our guests.

ANTHRACENE CENTENARY.

This year marks the one-hundredth anniversary of the discovery of anthracene by Dumas and Laurent, who obtained it by distilling coal tar and investigating the higher boiling fractions. For about 35 years it was of no importance until Graebe, Lietermann and Caro in Germany and Perkins in England used it in the preparation of alizarin and within a short eight years wiped out the French madder industry.

THERMAL SENSITIVITY OF FE_2O_3 CATALYST.

By Kinnosuke Yoshimura.

This investigation was made in order to know (1) the temperature at which Fe_2O_3 catalyst begins to lose activity and (2) its reason.

Catalyst No. 1a was taken as a sample. It was prepared by precipitation process, using a solution of iron nitrate and ammonia, its purity being given in the following table. The details were reported in a previous paper (*Journal Chemical Soc. Japan*, 1931, *34*, 197B).

Impurities (in g of every 100 g of Fe)

Si	Cu	Al	Cr	Mn	Ni	Ca	S
nil	nil	nil	nil	0.071	nil	nil	Trace(?)

The following points were investigated.

1. As described in the previous papers, Fe_2O_3 catalyst here used is composed of numerous fine crystals. According to Taylor (*Pro. Roy. Soc.*, 1925, *108*A, 105; *J. Phys. Chem.*, 1926, *30*, 143) and Schwab and Pietsch (*Z. Phys. Chem.*, 1928, *1*B, 385; *Z. Electrochem.*, 1929, *35*, 573), it seems to be reasonable to regard the corners and edges of these crystals, which are exposed to the reacting gases, to be the main centre of a catalytic action and also as being sensitive to heat as well as the action of poisons. The atoms positioned in these parts have their valencies unsaturated and, therefore, have a greater freedom of motion.

On this point of view, the author examined the activity of the catalysts which were roasted for 5 hours in the current of purified air at various temperatures from 317° to 962° C. The theoretical percentage of CO oxidation is 69.2% under the conditions the activity was examined. The following results were obtained.

Roasting Temperature(°C)	317	520	622	666	692	725	744	784	850	962
Weight (g)	1.3746	1.3926	1.7190	1.8059	—	2.2747	—	2.6283	2.6723	2.6829
CO Oxidation (%)	88.5	89.5	90.5	91.0	89.4	83.5	63.2	9.0	5.0	0.4

The results show that the activity of Fe_2O_3 begins to decline sharply at the temperature just below 700° C., and below this point no thermal effect is observed.

2. According to Hedvall (*Z. phys. Chem.*, 1926, *123*, 33), when iron oxides, Fe_2O_3 and Fe_3O_4, were heated in the form of a pastille, there was observed a diminution of its volume even at temperatures below their sintering points. The sintering temperatures varied from 850° to 930° C., depending upon various factors. W. Jander (*Z. angew. Chem.*, 1928, *41*, 75) ascribed this phenomenon to the exchange of the positions of atoms among the crystals, which were composed of the granules of Fe_2O_3. In other words, according to the present author, on heating the unsaturated atoms which lie in the crystal angles and corners will change their positions to more saturated configuration even at the temperatures far below the sintering points above cited.

Based on this view, the author extended the work of Hedvall to the lower side of temperature with a view to finding out a certain point at which the pastille of Fe_2O_3 would commence the diminution of its volume abruptly and found it between 650° to 700° C. And this point was found to coincide with the temperature at which Fe_2O_3 catalyst began to lose its activity as shown in the preceding paragraph.

3. In his work, Hedvall (*Z. Electrochem.*, 1931, *37*, 130) reported that the velocity of reaction of the system of Fe_2O_3—SiO_2 was exceedingly accelerated at a temperature at which the allotropic change of SiO_2 takes place. In this experiment, therefore, the transformation of Fe_2O_3 was studied by means of differential thermal analysis in the range of 350°-900° C. The results showed a thermal change at 685°-700° C. The change was progressive and reversible with respect to temperature and did not take place at a definite temperature as in the case of an allotropic change. That is, during cooling, the evolution of heat began to occur at 700° C. and extended to 600° C; during heating, a reverse change took place while no further transformation was observed.

Hence, Fe_2O_3 has no allotropic transformation in the temperature range above mentioned but a magnetic one at 685°-700° C. Although this point agreed with the temperature at which the catalyst began to lose its activity and the pastille made of it commenced to

diminish its volume abruptly as reported here, it is not concluded that the activity drop by thermal influence and the magnetic transformation of the catalyst are closely connected, because a magnetic transformation is the change within atoms themselves and not that of the atomic configuration from one space-lattice to the other.

From the foregoing, it can be pointed out that pure Fe_2O_3 begins to lose its activity at the temperature just below 700° C. The reason is as follows: At the temperature above mentioned, the unsaturated atoms, which lie in the crystal corners and angles and to which the catalytic activity is mainly attributed, begin to shift to more stable configuration, owing to the exchange of their positions among the fine crystals, of which the catalyst is composed.

THERMAL INFLUENCE UPON THE ACTIVITY OF FE_2O_3-CR_2O_3 CATALYSTS.

By Rinnosuke Yoshimura.

In continuation of the preceding paper, the author examined the influence of Cr_2O_3 upon the transformation point of Fe_2O_3 and also observed the temperatures at which the pastilles made of Fe_2O_3-Cr_2O_3 catalysts would commence the diminution of their volumes.

The following eight catalysts were prepared by simultaneous precipitation from solutions of nitrate of iron and chrome with ammonium hydroxide. The details were the same as reported in the report above.

Catalyst	No. 1a	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
Fe_2O_3 : Cr_2O_3 (Mol % of Cr_2O_3)	0	0.7	1.8	5.2	7.0	9.1	19.3	52.5	100

The purity of No. 1a and No. 9 are given in the following table.

Table 1.

Impurities (in g of every 100 g of Fe)

Catalyst	Si	Cu	Al	Cr	Mn	Ni	Ca	S	P
No. 1a	0.082	0.014	0.121	0.012	0.344	0.020	0.053	0.004	0.025

Impurities (in g of every 100 g of Cr)

Catalyst	Si	Cu	Al	Mn	Ni	Co	Fe	As	Sn	Mg	P	S
No. 9	nil	nil	nil	Trace	nil	nil	0.114	nil	nil	nil	nil	0.437

Since the other catalysts are regarded as the mixtures of the former two in such molecular proportions as above mentioned, their purity may be estimated from the results shown in Table I.

From the results obtained in the third report, it is known that the two oxides in Fe_2O_3-Cr_2O_3 catalysts become intimately mixed forming a solid solution.

The results are shortly summarized as follows:—

I. Using a differential thermal method of analysis, the influence of Cr_2O_3 on the magnetic transformation point of Fe_2O_3 at 680° C was studied. The transformation point was lowered in linear proportion to the added Cr_2O_3, until 19 mol% was added and 450° C was reached, while No. 8 (52.5 mol%) showed no thermal change in the temperature range of 350°-1000° C. These results coincided with that of H. Forestier and G. Chaudron (*Compt. rend.*, 1925, *180*, 1265).

2. Using a dilatometer and other methods, the author studied the temperatures at which the pastilles made of powdered Fe_2O_3-Cr_2O_3 catalysts would begin to contract abruptly. The sizes of grains were about 0.005 mm in diameter. The pressure applied to the pastilles was 1.29×10^3 kg per cm². The pastilles were 10-14 mm in length and 12 mm in diameter. The results showed no influence of Cr_2O_3 upon the temperature mentioned above. That is all pastilles except that of No. 9 (Cr_2O_3) commenced to contract their volumes at the temperature from 650° to 700° C.

Hence it is known that the temperatures, at which the pastilles made of powdered Fe_2O_3-Cr_2O_3 catalysts commence the diminution of their volumes, do not correspond to the points of magnetic transformation of the catalysts.

[Chem. Institute, Ryojun College of Engineering,
Port Arthur, S. Manchuria.]

DENSITY DETERMINATIONS OF CALCITE. ITS GRATING CONSTANT AND THE BEARING OF THE LATTER ON CERTAIN PHYSICAL CONSTANTS.

In a paper by J. A. Bearden, which appeared in the *Physical Review* of December 15, 1931, pp. 2089-2098, the following experimental data are given:—

Six calcite crystals, two from Iceland, two from Montana, one from Argentina and one from Spain, at 20.00° C. (± 0.01) gave a diffraction angle (θ) of 27° 51′ 34.x″, using the Mo $K\alpha_1$ line in the 4th order, where x is the value of the first decimal place which varies from .0 to .7. x = .4 in the *mean* value. Density (ρ) = 2.710x, where x varies from 2 to 4 in the 4th decimal place the mean value being 2.71026. The probable error (by the method of least squares) ranged from ± 0.000015 to ± 0.000081. The masses of the crystals varied from 11 to 15 grams with one of 7 grams. The above density agrees well with the value of De Foe and Compton (*Phys. Rev.*, 1925, *25*, 618), *viz.*: 2.71030 ± 0.00003. In the present investigation of Bearden the crystals contained 99.98% of calcium carbonate, the impurity being the oxides of Mn and Fe amounting to 0.02%. The grating constant $d = (mM/\rho N\phi)^{1/3}$ = 3.02816Å at 20° C., = 3.02810Å at 18° C. The values used in the equation were those given below in the discussion, while ϕ = 1.09594 (± 0.00001), which is the volume of a rhombohedron with unity perpendicular distance between opposite faces.

Since the physical constants are of importance to those concerned in theory and the application of formulæ, the following from Bearden's paper, though covering some very familiar ground, should be of educational interest.

For a calcite crystal $n = \frac{1}{2}$ (W. H. Bragg and W. L. Bragg, X-RAYS AND CRYSTAL STRUCTURE). Birge (*Phys. Rev. Supplement*, 1929, *1*, 1) gives the molecular weight of calcite M = 100.078 ± 0.005. The density as above is ρ = 2.71030 ± 0.00003. Avogadro's number can be most accurately determined from the relation $N = Fc/e$, where F is the Faraday constant, c the velocity of light, and e the charge on the election. Birge (*loc. cit.*) gives Fc = 2.8927 ± 0.0002 × 10^{14} Abs. e.s.u., and e = 4.770 ± 0.005 × 10^{-10} e.s.u. From Millikan's experiments Birge obtained a value of e = 4.768 × 10^{-10} e.s.u., and in consideration of Wadlund's (*Phys. Rev.*, 1928, *32*, 841) grating wave-length measurements of X-ray spectra which gave e = 4.774 × 10^{-10} e.s.u. raised Millikan's value to 4.770 × 10^{-10} e.s.u. More recent grating measurements by the writer (J. A. Bearden, *Phys. Rev.*, 1931, *37*, 1210) have shown that e, from such experiments, is 4.806 × 10^{-10} e.s.u. It appears to the writer to be out of the question to average this result with that of Millikan's [it would be 4.787]. The difference of such an average from the results of either experiment would be many times the experimental error of either. The writer thus believes it is preferable to retain Millikan's value, 4.768 ± 0.005 × 10^{-10}, until the magnitude of the mosaic structure can be determined and the validity of the grating formula established for X-ray wave-lengths. From this value of e one obtains N = 6.0669 × 10^{23} molecules/mole. The value of d is then calculated to be as above. The probable error is ± 0.001, which is almost entirely due to the probable error in e. This value is about one part in 3000 lower than the value adopted by Siegbahn (SPEKTROSKOPIE DER RÖNTGENSTRAHLEN). Bearden goes on to say:—In order to calculate the true wave-length of an X-ray line with the true grating constant as determined above, the complete Bragg law $n\lambda = 2d\,[1 - (1 - \mu/\sin^2\theta)]\sin\theta$ must be used where λ is the true wave-length, d the true grating space, μ the index of refraction, and θ the diffraction angle for the n-th order. If we use the value $(1 - \mu)/\lambda^2 = 3.69 \times 10^{-6}$ the above equation becomes $n\lambda = 2d[1 - (135 \times 10^{-6}/n^2)]\sin\theta = 2d_n \sin\theta$, where d_n is the effective grating constant for the n-th order. With the true grating constant d = 3.02810, the calculated values of d_n and log $2d_n$ are as follows:— d_1 = 3.02769 Å, d_2 = 3.02799, d_3 = 3.02805, d_4 = 3.02807, d_5 = 3.02808, ... d_∞ = 3.02810; the corresponding log values are 0.7821415, 0.7821752, 0.7821937, 0.7821966, 0.7821980 . . . . log $2d_\infty$ = 0.7822002. In compiling the above from Bearden's paper

the present writer has contracted the expressions or matter so as to economise in space.

In the concluding discussion Professor Bearden says that the difference in density does not reflect itself as a corresponding change in the grating constant of the crystal. Consequently the measured density may not be the real density of the crystal lattice which is responsible for the diffraction of the X-rays. In the concluding words it is stated that: The difference between the writer's ruled grating wave-length measurements (*loc. cit.*) and the corresponding crystal results now is 0.25% instead of 0.22% as previously given. Such a great difference must be due to a failure of the ruled grating diffraction equation to be valid for the X-ray region. The boundary conditions are probably not the same for optical wave-lengths and X-rays and might thus alter the position of the diffraction maxima. A careful analysis of the diffraction theory for X-ray wave-lengths and for the conditions under which X-ray spectra are obtained is badly needed in order to settle the questions raised by such experimental differences.—F. H. L.

DYESTUFFS AND DERMATITIS.

Mention is made of the increased number of cases of dermatitis alleged to be caused by dyed garments, including furs, and of the frequent lack of adequate proof of the supposed irritant action of certain dyes and of the difficulties due to idiosyncrasy.

A list is given of dyed and other pigments which have been investigated experimentally—mainly by Weyl and Sachs—shewing which were found to be nocuous and which innocuous. Many of the reports in medical literature on this subject are vitiated by inadequate information on the identity of the dyestuffs concerned.

Appropriate methods of extraction for testing are considered and figures given shewing the extent of reduction of certain azo dyes by natural wool or fur and of Bandrowski's base in acid solution. As a result it is suggested that the suspect material should be extracted at blood heat with normal saline containing 0.1 per cent. of acetic acid and not with a mineral acid. It is suggested that the substances in question are only to be considered harmful when present in the free state in appreciable quantity and so transferable to the skin of a wearer.

Summary of paper read before The London Section of the Society of Dyers and Colourists by Dr. H. E. Cox, M.Sc., Ph.D., F.I.C., and published in the May issue of the Journal of the Society.

IMPORT DUTIES ADVISORY COMMITTEE.

The Import Duties Advisory Committee give notice that they are considering applications made under Section 1 (3) of the Import Duties Act, 1932, for the addition of the following goods to the Free List:—

Citrate of lime.
Emery stone or ore in the unground condition.
Mercury.
Argol and other crude tartrates.
Gallnuts.
Kelp.

Any representations concerning these applications should be addressed in writing to the Secretary, Import Duties Advisory Committee, Caxton House (West Block), Tothill Street, London, S.W. 1, not later than the 14th May.

The Manchester City Council is again offering a number of Scholarships tenable in the Faculty of Technology of the University of Manchester. Successful candidates are required to follow a full-time course leading to the degree of Bachelor of Technical Science in the College of Technology and Matriculation or its equivalent is an essential qualification.

For students who have been engaged in industry, and who have attended part-time day or evening classes, the Scholarships are of the value of £100 per annum, while for students leaving Secondary or Central Schools the value is £60. Both classes of Scholarships are tenable for three years.

Proceedings and Notices of Societies.

ROYAL INSTITUTION.

The Annual Meeting of the Members of the Royal Institution of Great Britain was held on Monday afternoon (May 2nd), Sir Robert Robertson, *Treasurer and Vice-President*, in the chair. The Annual Report of the Committee of Visitors for the year 1931, which was received and adopted at the meeting, referred to the completion of the alterations to the building, and said that in safety and suitability for the purposes for which it exists, in completeness of equipment, and in spaciousness and beauty, the House of the Institution now compared favourably with any in London. The principal activity of the Institution during the year had been the share it had taken in the arrangement of the Faraday Celebrations, which had proved an impressive and remarkable demonstration in honour of the memory of a great man.

During the year sixty-seven new Members and fourteen Associate Subscribers had been elected; and seventeen new Honorary Members had been added to the roll from among the distinguished foreigners who attended the Faraday Celebrations. Thanks were voted to the Officers and to the Committees of Managers and Visitors for their invaluable services during a period of great activity in the history of the Institution. The following were unanimously elected as Officers for the ensuing year—*President*: The Right Hon. Lord Eustace Percy. *Treasurer*: Sir Robert Robertson. *Secretary*: Major Charles E. S. Phillips.

Managers: Sir Frederick Berryman, Sir John Cadman, Dr. Ernest Clarke, Sir James Crichton-Browne, Professor Alfred Fowler, Sir Robert Hadfield, Dr. K. R. Hay, Mr. J. S. Highfield, Sir Arthur Keith, Sir William Larke, Lord Luke of Pavenham, Mr. Charles H. Merz, Sir Richard Paget, Mr. H. M. Ross and Dr. G. C. Simpson.

Visitors: Dr. C. V. Drysdale, Dr. J. J. Fox, Professor G. E. Gask, Mr. Arthur Jaffe, Dr. G. W. C. Kaye, Mr. James Kewley, Mr. Arthur Marshall, Mr. Emile S. Mond, Professor A. O. Rankine, Dr. Russell J. Reynolds, Mr. T. H. Sowerby, Major W. S. Tucker, Professor A. M. Tyndall, Admiral C. V. Usborne and Mr. H. E. Wimperis.

THE FACULTY OF SCIENCES.
THURSDAY, MAY 5, 1932.

At a meeting of the Council of The Faculty of Sciences, held in London, Professor Dr. M. Rebek was elected a Vice-President.

Professor Dr. Rebek is Professor of Organic Chemistry at the King Alexander University, Ljubljana, Jugoslavia. He is well known in mid-European scientific circles and has considerable publications to his credit, on Dyestuff Radicals, Tautomerics, and problems of triphenylmethane and sulphite lye. Much of Professor Rebek's work has been published in the *Chemical News* and *Collection of Czechoslovak Chemical Communications.*

THE PHYSICAL SOCIETY.
VISIT TO NOTTINGHAM, JUNE 11, 1932.

The members of the Physical Society, through the kindness of Professor H. L. Brose, M.A., Ph.D., F.Inst.P., have been invited to visit the Physics Department of the University of Nottingham on Saturday, June 11, 1932. It is proposed to leave St. Pancras at 9 a.m. by a train which arrives at Nottingham at 11.15 a.m. It has been arranged for the party to inspect the Council House before lunch. A meeting of the Society will be held at 2.30 p.m. at the College. During the afternoon it is proposed that ladies and friends inspect Messrs. Players' Factory and afterwards drive to Newstead Abbey. Tea will be served in the College Refectory at 4.45. The return fare will be charged at the special rate of 15s. 6d.

Further particulars and details will be announced later.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.
APRIL EXAMINATIONS, 1932.
PASS LIST.

Examination in General Chemistry for the Associateship.

Blenkinsop, John Clifford: West Ham Municipal College, and Birkbeck College, London.

Brooks, Arthur, A.M.C.T.: College of Technology, Manchester.

Clark, Malcolm Turner, B.Sc. (Lond.): Birkbeck College, and Sir John Cass Technical Institute, London.

Crowther, Walter Fred, A.M.C.T.: College of Technology, Manchester.

Denny, James Leslie, B.Sc. (Lond.): The Polytechnic, Regent Street, London.

Ferguson, William Hunter: The University, and the Royal Technical College, Glasgow.

Hartley, Herbert Kent, B.Sc. (Manc.): The University, Manchester.

Ikin, Gilbert, A.H.C.T.: College of Technology, Manchester.

Jackman, Frank Arthur, B.Sc. (Lond.): Birkbeck College, London.

Marsh, Norman: Central Technical School, Liverpool.

Marshall, George Reginald, B.Sc. (Lond.): Chelsea Polytechnic, London.

Miller, David: The Polytechnic, Regent Street, London.

Weber John Henry, B.Sc. (Lond.): Birkbeck College, London.

Wescott, Cecil Ernest Arnaud, B.Sc. (Lond.): Birkbeck College, London.

White, George, B.Sc. (Lond.): Sir John Cass Technical Institute, London; and Wigan and District Mining and Technical College.

Wilson, Matthew Sillars: Royal Technical College, Glasgow.

Examinations for the Fellowship.

In Branch C: Organic Chemistry, with special reference to Soaps and Edible Oils.

Owen, Arthur Ernest, B.Sc. (Lond.).

In Branch E: The Chemistry, including Microscopy, of Food and Drugs, and of Water.

Bagnall, Douglas James Talbot, A.C.G.F.C.
Garratt, Donald Clarence, B.Sc. (Lond.).
Lee, Herman, B.Sc. (Lond.).
Lewin, John Upton, B.Sc. (Lond.), A.C.G.F.C.
Love, Malcolm McFarlane.
Naidu, Sura Rajagopal, B.A., M.B., B.S. (Madras).
O'Sullivan, Daniel Joseph, B.Sc. (N.U.I.).
Wilson, William.

In Branch F: Agricultural Chemistry.
Botham, George Henry, B.Sc. (Lond.).
Bywaters, Michael Fawckner, M.Sc. (Lond.), A.R.C.S., D.I.C.

In the Chemical Technology of Textiles.
Cowpe, William.

THE INSTITUTE OF METALS.

The Twenty-second Annual May Lecture of the Institute of Metals was delivered by Professor Dr. F. Korber (Director, Kaiser Wilhelm-Institut fur Eisenforschung, Düsseldorf), on Wednesday, May 11, at 8 p.m., at the Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S.W.1, the subject of the Lecture being "The Plastic Deformation of Metals."

Friedrich Korber was born on April 1, 1887, at Duisburg, Germany. From 1905-1910, he studied mathematics, physics and chemistry at the University of Göttingen and München. He received his degree of Dr. phil. in 1909, as a result of work on physical chemistry which was sponsored by Professor G. Tammann, Göttingen. Afterwards he was assistant at the Physical Chemical Institute at the University of Göttingen until the outbreak of the war. From 1917 to 1920 he was lecturer in physical metallurgy at the Technical High school, Aachen. In 1920 he went to the Kaiser-Wilhelm Institut für Eisenforschung in Düsseldorf as departmental director and became its director in 1922. He was given an honorary degree of Doctor of the Technical High school, Dresden, in 1929, and was elected honorary Professor of the Technical High school, Aachen in 1929.

His chief work is connected with the physical chemistry of metals, especially iron and steel, and with processes of production of steel. He has done much work on the testing of materials and on the examination of the properties of iron and steel. He is a member of the Deutschen Verbandes für die Materialprüfungen der Technik, of the Verein deutscher Eisenhuttenleute, and of the Institute of Metals.

UNIVERSITY NEWS.

Bayliss-Starling Memorial Scholarship.

In commemoration of Prof. Sir William M. Bayliss and Prof. E. H. Starling, the above scholarship (in physiology and/or Bio-chemistry), were founded in 1929, tenable at University College, London. Applications should be made before May 14, to Secretary of University College. The annual value is £120, with exemption from tuition fees.

Notices of Books.

The Theory of Electric and Magnetic Susceptibilities by PROFESSOR J. H. VAN VLECK, Professor of Theoretical Physics at the University of Wisconsin, xi + 384. Humphrey Milford: The Oxford University Press, London, and the Clarendon Press, Oxford. Price 30s. net.

This is the third volume in the *International* Series of Monographs in Physics, edited by R. H. Fowler and P. Kapitza, the first and second being DIRACS' *Principles of Quantum Mechanics* and GAMOW'S *Constitution of Atomic Nuclei and Radio-activity*, 1930 and 1931 respectively

Professor Van Vleck, has contributed in this important volume as far as is possible, a work, of interest to those readers with a mathematical training and most certainly intelligible to the reasonably well informed general reader. The book contains:—Classical Foundations. Classical Theory of the Langevin-Debye Formula. Dielectric Constants, Refraction, and the Measurement of Electric Moments. The Classical Theory of Magnetic Susceptibilities. Susceptibilities in the Old Quantum Theory, contrasted with the New. *Quantum-Mechanical Foundations.* Quantum-Mechanical Derivation of the Langevin-Debye Formula. The Dielectric Constants and Diamagnetic Susceptibilities of Atoms and Monatomic Ions. The Paramagnetism of Free Atoms and Rare Earth Ions. The Para-and Diamagnetism of Free Molecules. The Paramagnetism of Solids, especially Salts of the Iron Group. Heisenberg's Theory of Ferromagnetism; Further Topics in Solids. Brief Survey of some Related Optical Phenomena.

In the new quantum-mechanics, the field of spectroscopy plays a great part. Herein that subject has received attention. The first four chapters are devoted to Classical Theory, and in Chapter III, the Comparison of Theory with Experiment regarding dielectric constants is included. This has been done without making the comparison obsolete, because the new quantum mechanics has restored the validity of many classical theorems violated in the old quantum theory. The necessary perturbation theory and theorems of spectroscopic stability are developed in Chapter VI, and Professor Van Vleck has correlated and intermingled the use of wave functions and matrices, rather than relied exclusively on the one or the other, as is too often done.

Salts of the rare Earths and iron groups are examined in considerable detail. A theory is developed to explain why, as conjectured by Stoner, inter-atomic forces obliterate the contribution of the orbital auguear momentum to the magnetic moment in the iron group. Included in Chapter XII are the aspects of ferro-magnetism so far amenable to the Heisenberg theory, which has at long last divested the Weiss molecular field of its mystery. Here the discussion is centred on the thermal behaviour of the Saturation, rather than on hysteresis and retentivity.

Professor Van Vleck, in this volume, has made a valuable contribution to the Literature of Physics and this book is well worthy of the attention of those interested in the subject.

H. W. B. R.

TWELFTH CONGRESS OF INDUSTRIAL CHEMISTRY AT PRAGUE.

The twelfth Congress of Industrial Chemistry is being held this year at Prague, Czechoslovakia, from September 25th to October 1st.

The Organising Committee has arranged an attractive programme including a series of discussions and numerous works, visits, and excursions of special interest to those engaged in the Chemical Industries.

Any British chemist or industrialist contemplating taking part in the Congress is invited to write to the Organising Secretary, Congres de Chimie Industrielle, 37, Stepanska, Prague, II, Czechoslovakia.

New Patents.

These particulars of New Patents of interest to readers have been selected from the Official Journal of Patents and are published by permission of the Controller of H.M. Stationery Office, and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

Latest Patent Applications.

11,649.—Metallges. Akt.-Ges.—Production of alkali phosphates. April 22.

11,229.—Wetail.—Production of ammonium sulphate. April 19.

Specifications Published.

370,889.—Process Development Co.—Process for preparing carbon dioxide and siliceous materials.

371,307.—Alterra Akt.-Ges.—Process for separating aluminium hydroxide from silicic acid.

Group Abridgments can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, either sheet by sheet as issued on payment of a subscription of 5s. per Group Volume or in bound volumes price 2s. each.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, at the uniform price 1s. weekly.

Abstract Published.

366,107.—Hydrocarbons.—Johnson, J. Y., 47, Lincoln's Inn Fields, London,—(I. G. Farbenindustrie Akt.-Ges. Frankfort-on-Main, Germany.

In thermal treatments of organic products, such as the cracking of oils, the polymerization of oilfines or cracking gases into benzene, the conversion of methane into benzene or olefines, the conversion of methane and its homologues with steam or carbon dioxide into carbon monoxide and hydrogen, or in the reduction of phenol, cresol, and the like with hydrogen, the deposition of carbon is avoided by providing the surfaces of ceramic apparatus which come into contact with the hot organic materials, with a complete or partial covering of oxides of chromium, tungsten, vanadium, or uranium. For example, chamotte tubes or bricks or unglazed porcelain tubes are impregnated with aqueous chromic acid or chromium salts (or chromates which form chromium oxide on heating) and then heating for instance to 1,600° C.; or the metal compounds may be incorporated in the materials from which the ceramic material is made. Catalysts may also be employed, incorporated in the surfaces in a similar manner. In examples (1) an internally unglazed porcelain tube is soaked with a 50 per cent. aqueous chromic acid and dried at 400° C., this being repeated three times; methane is passed through this tube at 1,075-1,100° C. to produce benzene hydrocarbons and hydrogen; (2) methane is passed through a fireclay tube impregnated with chromic acid and is converted into benzene hydrocarbons and hydrogen at 1,100-1,200° C.; (3) vapour of paraffin oil (b.p. 330-380° C.) is passed at 650-700° C. through a porcelain tube impregnated with chromic acid, 41 per cent. of oils and 61 per cent. of gases being produced; of the oils 60 per cent. are of b.p. up to 200° C. and 16 per cent. of b.p. 200-300° C., while the gas contains 40 per cent. of olefines, 48 per cent. of methane and its homologues and 10 per cent. of hydrogen; (4) ethylene is passed at 700-750° C. through a similar tube, 15 per cent. of the ethylene being converted into a liquid containing 50 per cent. of benzene and 50 per cent. higher aromatic hydrocarbons; the gas contains 39 per cent. of ethylene, 38 per cent. of methane and 21 per cent. of hydrogen. Specification 317,359 [*Class* 2(iii), Dyes &c.], is referred to.

The Latest Trade Marks.

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of H.M. Stationery Office, and the Trade Marks Journal can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

H. S.

B527,494.—Spectroscopically standardised chemical substances for use in spectroscopic and physical research.—Adam Hilger, Limited, 24, Rochester Place, Camden Town, London, N.W. 1. April 27.
User claimed from April 3, 1929.

FLODIA.

530,206.—Chemical substances used as fixatives in the manufacture of perfumery and prevent the perfumes evaporating quickly.—Howards & Sons, Limited, Uphall Road, Ilford, Essex. April 27. (Associated.)

MIMO.

529,801.—Photographic chemicals, plates and films (sensitized).—Mimosa Aktiengesellschaft, 31, Barenstainstrasse, Dresden, A.21, Germany. April 27. (Associated.)

NOVUTOX.

530,396.—Chemical substances use for agricultural, horticultural, veterinary and sanitary purposes, but not including liniment or embrocation and not including any goods of a like kind to liniment or embrocation. —Pharmaceutical Corporation, Limited, 39, Aldersgate Street, London, E.C. 1. April 27. (Associated.)

THE CHEMICAL NEWS

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MONOSACCHAROSE CONFIGURATIONS AND INTERRELATIONS

By J. F. SNELL, Professor of Chemistry, Macdonald College, Quebec.

Contribution from the Faculty of Agriculture of McGill University, Macdonald College, P.Q., Canada. Journal Series No. 13.

The accompanying diagram, presented to the Seventh Annual Convention of Canadian Chemists at Kingston, Ontario, in May 1924, but hitherto unpublished, is the equivalent of a circular one used by Rosanoff[1] in a 1906 paper in which he corrected the error of Emil Fischer in assuming that the gulose and glucose which yield the same saccharic acid belong to the same family (d or l). It is presented in the belief that it will be useful to teachers of organic chemistry. It is easier to construct and to read than a circular diagram and renders possible representation of the relation between aldoses yielding identical polyhydric alcohols by reduction and identical polyhydric dicarboxylic acids by oxidation—a set of relations which Rosanoff presented in a tabular annex to his diagram. It is similar to, but not identical with, and is more comprehensive than, that used by Emmet Reid in his textbook[2].

The relationship referred to above is one of the three types of relations upon which Fischer based his assignment of stereochemical formulæ. The other two have been given definite names, viz., enantiomerism and epimerism. This third one would appear to have equal claim to verbal designation. In its case, however, more than one term is required to express all the types of relations. Words expressing these relations can be coined from familiar syllables and it is believed that the usefulness of such terms will fully justify their introduction.

Definitions.

In the subsequent discussion it will be convenient to have at hand definitions of some current terms as well as of the new ones proposed. Those believed to be new will be indicated by asterisks, preferred *synonyms* by italic type.

Asymmetric carbon atom.—A carbon atom to whose four bonds are attached

atoms or groups no two of which are structurally identical.

Pseudosymmetric carbon atom* (Pseudo-asymmetric carbon atom). A carbon atom attached to two dissimilar atoms or groups and to two which are identical structurally but may differ in configuration. Examples: The central carbon atom in the pentitols, heptitols, etc., and the corresponding one in the polyhydric dicarboxylic acids of odd rank. (The briefer form *pseudosymmetric* appears to express the idea of apparent but conditional symmetry better than the current one *pseudoasymmetric*.)

Families—λ and δ. Two great groups of genetically related compounds, each including aldoses, ketoses, aldonic acids, ketonic acids, polyhydric alcohols, polyhydric dicarboxylic acids, etc.

*Rank**—A group of compounds characterized by the same number of asymmetric, or of asymmetric + pseudosymmetric, carbon atoms. The ranks may be designated by this number. Thus Rank 1 includes the glyceroses; rank 2 the tetrose aldoses and the pentose ketoses; rank 3, the pentose aldoses, hexose ketoses and methyl (aldo) pentoses, etc.

Functional group.—The aldehyde group of aldoses, the carbonyl of ketoses, the carboxyl of acids, etc.

Enantiomers, enantiomeric pairs, enantiomorphs, optical antipodes—Pairs of compounds whose formulæ are interrelated like object and mirror image.

Epimers, epimeric pairs.—Substances whose formulæ differ only in the configuration on the asymmetric carbon atom next to the functional group.

Epigen, epigenic aldose**.—The aldose of one rank which by cyanhydrin synthesis yields an epimeric pair of aldoses of the next higher rank. Thus glycolose is epigenic to the two glyceroses; the glyceroses (l- and d-) are epigenic to the erythroses and threoses; each arabinose is the epigen of the glucose and mannose of its own family, etc.

*Idioloses**.—Aldoses which have polyhydric alcohols and polyhydric dicarboxylic acids peculiar to themselves (*idios*, one's own, *ol*, alcohol, *ose*, sugar). The idiogenic* alcohols and dicarboxylic acids of enantiomeric aldoses are themselves enantiomers. Examples: λ- and δ- threose and idioloses, the λ- and δ- erythritols being the idiogenic alcohols and the λ- and δ- tartaric acids the idiogenic acids.

*Isoloses, isolic pairs**.—Pairs of aldoses yielding a common alcohol and a common dicarboxylic acid. These are of three types:

(a) *Mesoloses*, mesolic pairs**.—Enantiomers yielding (inactive) *meso* alcohols and acids. Examples: l- and d- erythrose, l- and d- ribose, l- and d- galactose.

(b) *Homoloses*, homolic pairs**.—Aldoses of the same family yielding a common alcohol and acid of their own family. Examples: l-arabinose and l-lyxose, d-altrose and d-talose.

(c) *Amphioloses*, amphiolic pairs**.—Non-enantiomeric aldoses of opposite family, yielding a common (active) alcohol (and acid), which cannot be assigned to either family. Examples: d-glucose and l-gulose, l-glucose and d-gulose. It was the existence of these that Fischer overlooked. They make their first appearance in the fourth rank (that of the hexose aldoses).

The prefix *amphi* (on both sides) was suggested by Rosanoff (l.c.).

Adjectives applying to polyhydric alcohols and polyhydric dicarhoxylic acids:

*Idiogenic**—yielding an idiolose.

Mesogenic, meso-compounds*—yielding a paid of mesoloses.

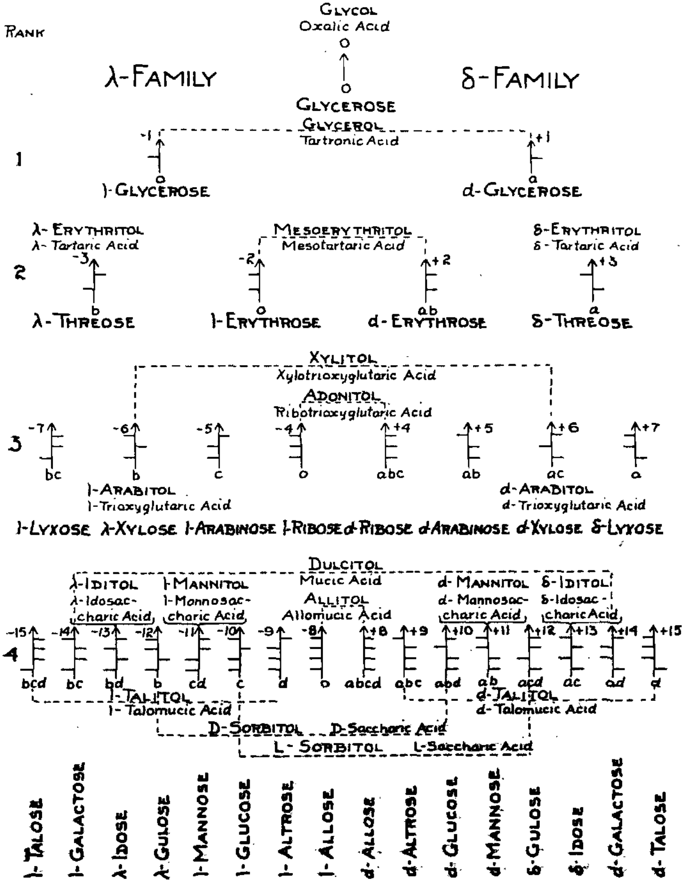
*Homogenic**—yielding a pair of homoloses.

*Amphigenic**—yielding a pair of amphioloses.

Notation.

The Greek letters λ and δ are prefixed to the compounds whose Fischer (or older) designations were altered by Rosanoff. Some of these, such as the tartaric acids, are universally designated in the older way, common dextrorotatory tartaric acid being known as d-tartaric. For others some writers still use l- and d- on the names of compounds so designated by Fischer, while others use them in place of Rosanoff's λ and δ. Confusion is avoided by continuing the use of the Greek letters on those compounds whose designation differs in the two systems but using l- and d- where there is full agreement. The capitals L- and D- are used for amphigenic compounds. The only examples within the compass of the chart

INTERRELATIONS OF THE ALDOSES POLYHDRIC ALCOHOLS AND HYDROXYDICARBOXYLIC ACIDS



are the saccharic acids and sorbitols. Here D- is assigned to the acid which is actually dextrorotatory in aqueous solution and to the genetically related sorbitol. No attempt is made to represent actual directions of rotation in the notation.

Some Features of the Chart.

Rosanoff's "*semaphore*" (*or* "*skeleton*") formulæ are employed, the functional group being placed upward and represented by an arrowhead. (For a ketose the arrowhead may be placed lower on the vertical line). As usual, the vertical lines represent the chains of carbon atoms, the horizontal arms the orientation of the *OH* groups (The structure symbols of Hackh[3] offer an alternative to these skeleton formulæ and would no doubt be preferable with students accustomed to that convenient system). In the δ family the lowest arm of all the formulæ is directed to the right, in the λ family to the left. Enantiomers are symmetrically placed with respect to the vertical line dividing the two families. Epimeric pairs stand beneath their epigens. The members of each isolic pair are connected by a dotted line along which are written the names of the polyhydric alcohol and dicarboxylic acid common to them. The names of idiogenic alcohols and acids appear above their idioloses. It is to be noted that if the *arrows be removed any idiolic formula* rotated through 180° in the plane of the paper gives itself again, while any isolic formula gives that of the other isolose.

Rosanoff's numbers stand above the formulæ to which they apply and read serially throughout each half chart (those of the λ family, of course, from right to left). Below the formulæ stand letter combinations which serve the same purpose as the numbers suggested by Sattler.[4] The letter ***a*** is common to all the δ formulæ but is absent from the λ side of the chart. Each enantiomeric pair has the full quota of the letters appropriate to its rank, *e.g.*, in Rank 6, l-allose is aldohexose-*o*, d-allose, aldohexose-***abcd***; l-altrose; aldohexose-***d***, d-altrose, aldohexose-***abc***. Similarly, in Rank 5, d-fructose is aldoketose-***ab***, while l-fructose is aldoketose-***c***, d-arabinose aldopentose-***ab*** and l-arabinose, aldopentose-***c***

In reproducing the chart, or the sequence of letter combinations, all the ***ab*** formulæ are written nearest the middle line, then all the *ac* compounds and so on. Only the right half of the chart, or even the letter combinations of the formulæ, need be written to secure the correct sequence. The left half can then be filled in, if desired, by constructing mirror image formulæ of those on the right or by filling up the quota of letters for each pair of enantiomers.

Mnemonics.

Having constructed the right half of the chart or written the letter combinations in the proper order, the names of the compounds can be arranged by the use of *mnemonics. Erythrose and threose come in* alphabetical order. So, in the same rank, do the pentose ketoses. Whether that configured like erythrose be called arabinulose, araboketose or riboketose, it will precede xyloketose. The mnemonic: RIBald
abc
ARAB's XYL-o-LYX gives the order for
ab ac a
the pentose aldoses: *RIBose, ARABinose, XYLose* and *LYXose.* For the hexose ketoses, which belong to the same rank, ALL FRUits SORted and TAGged gives
abc ab ac a
the order:
ALLoketose, FRUctose, SORbose and *TAGatose.*

For the hexose aldoses the following mnemonic is easily memorized and interpreted:
ALLie ALTROSE, GLUm MAN's GULl,
abcd abc abd ab acd
IDa's GALlant TALent giving the order:
ac ad a
ALLose, ALTROSE, GLUcose, MANnose, GULose, IDose, GALactose, TALose.

The chart can easily be extended to higher ranks and the known heptoses, octoses, monoses and decoses placed, as was done in the Rosanoff diagram by Willaman and Morrow[5] in 1923. Indeed, the configurations of compounds of those ranks can be derived by merely increasing the number of letters in the letter combinations and giving to each pair of epimers the combination corresponding to that of their epigen. For example, the two epimeric heptoses derived from d-glucose (***abd***) would have the letter combinations: ***abde*** and ***abd***; the four octoses derived from these ***abdef*** and ***abde***, and ***abdf***

and *abd*; the eight nonoses from these *abdefg* and *abdef, abdeg* and *abde, abdfg* and *abdf, abdg* and *abd;* and so on. Configurational formulæ can be constructed accordingly.

The Fischer Assignment Argument.

With the help of the chart and the proposed new terms the Fischer argument can be presented simply and concisely.

Thus, confining attention to the δ family:

Formulæ 4 *and* 6 *represent mesolic pentose aldoses.*

Ribose and xylose are such compounds—reducing to separate inactive alcohols and oxidizing to separate inactive trioxyglutaric acids.

Formulæ 5 *and* 7 *represent a homolic pair.*

Arabinose and lyxose constitute a *homolic* pair, reducing to the active arabitol and oxidizing to a common active trioxyglutaric acid.

Formula 4 *is epigenic to a mesolic and a homolic hexose aldose, Nos.* 8 *and* 9, *respectively.*

Ribose by cyanhydrin synthesis yields allose, a *mesolose*, and altrose, a *homolose*. Therefore Formula 4 represents robise, formula 8 allose and formula 9 altrose.

Formula 5 (*homolic*) *is epigenic to an amphiolic and an idiolic hexose aldose, Nos.* 10 *and* 11, *respectively.*

Arabinose is *epigenic* to glucose, an *amphiolose*, and mannose, an *idiolose*.

Therefore Formula 5 represents arabinose, formula 10 glucose and formula 11 mannose.

Formula 6 (*mesolic*) *is also epigenic to an amphiolose and an idiolose, Nos.* 12 *and* 13.

The *mesolic* pentose xylose, is *epigenic* to the *amphiolic* gulose and the *idiolic* idose.

Therefore Formula 6 represents xylose, formula 12 gulose and formula 13 idose.

Finally, Formula 7 (*homolic with* 5) must represent lyxose, which yields the *mesolose* galactose, represented by Formula 14, and the *homolic* partner of altrose, viz., talose, represented by Formula 15.

Some Further Features of the Chart.

Formulæ of δ idioloses and homoloses have the OH next to the functional group directed to the left. Those of mesoloses and amphioloses have it directed to the right. The sum of the numbers of idioloses and homoloses in any rank is, therefore, obviously equal to that of the mesoloses and amphioloses. Using the initial letters of the words to represent numbers of isomers of the four classes, this relation can be conveniently represented by the algebraic formula:

$$i + h = m + a$$

Idioloses occur only in the even ranks. Therefore, in the odd ranks $h = m + a$, or half the aldoses of such ranks are homoloses.

If we represent the number of asymmetric carbon atoms in any rank by n, the number of enantiomeric pairs of compounds of each class of monosaccharoses can be derived by use of the following formulæ, where the subscript 2 indicates a pair:

When n is odd,

$$i_2 = O;\ h_2 = 2^{n-2};\ a_2 = 2^{n-2} - 2^{\frac{n-1}{2}};\ m_2 = 2^{\frac{n-1}{2}}$$

When n is even,

$$i_2 = m_2 = 2^{n/2-1};\ h_2 = a_2 = 2^{n-2} - 2^{n/2-1}.$$

In either case the total number of enantiomeric pairs is 2^{n-1}; the total number of optically active compounds distinguished by open chain formulæ 2^n and the total number of α and β mutation isomers (mutameis) 2^{n+1}.

Amphioloses, which make their first appearance in Rank 6, become, theoretically, quite numerous in the higher ranks. For instance, in Rank 8, among 128 isolic pairs 56 are amphiolic and in Rank 9 of 256 pairs 112 are amphiolic.

In the polyhydric alcohols of the odd-numbered ranks, the central carbon atom is pseudosymmetric. For compounds of this class the numbers of idiogenic, homogenic, amphigenic and mesogenic compounds (not pairs) in any rank is given by the following formulæ.

For the odd ranks:

$$i = O;\ \ h = 2^{n-1};\ \ a = 2^{n-1} - 2^{n/2};\ \ m = 2^{n/2};$$

Total, 2^n.

For the even ranks:

$$i = 2^{n/2};\ h = a = 2^{n-2} - 2^{n/2-1};\ m = 2^{n/2-1};$$

Total, $2^{n-1} + 2^{n/2-1}$.

Some of these formulæ do not apply where $n = O$ but that case has, of course, no scientific interest.

Summary.

1. A rectilinear equivalent of Rosanoff's circular chart of the monosaccharose aldoses is presented as having teaching value.
2. New terms are proposed to represent certain relationships amongst the monosaccharoses and related compounds.
3. With the use of the chart and new terms, Fischer's assignment argument is restated in an easily apprehended form.
4. Algebraic formulæ are given by use of which the numbers of possible open chain isomers of any class can be calculated for any number of asymmetric carbon atoms.

Literature Cited.

1. Rosanoff. "On Fischer's Classification of Stereo-isomers." J. Am. Chem. Soc., *28*, 114-121 (Jan., 1906).
2. Reid, E. Emmet. "College Organic Chemistry." D. Van Nostrand Co., New York, 1929, p. 385.
3. Hackh. "Structure Symbols of Organic Compounds." P. Blakiston Son & Co., Philadelphia, 1931.
4. Sattler. "A Number System for Sugar Configurations." J. Chem. Educ. *8*, 1,369 (July, 1931).
5. Willaman and Morrow. "A Revision of Rosanoff's Diagram of the Aldose Sugars." J. Am. Chem. Soc., *45*, 1,273-1,280 (May, 1923).

Department of Chemistry,
Faculty of Agriculture,
Macdonald College,
McGill University.

X-RAY WAVE-LENGTHS BY THE DISPERSION IN QUARTZ AND e/m CALCULATED THEREFROM.

J. A. Bearden in the *Physical Review* (1932, *39*, 1-7) gives a paper entitled: X-Ray Wave-Lengths by the Dispersion in Quartz; the following being Prof. Bearden's abstract, except that the equation is arranged on a level setting:—It has been shown that the quantum theory of dispersion accounts satisfactorily for the measured refraction of X-rays. Since the X-ray wave-lengths as determined by crystals and by ruled gratings differ by 0.25 per cent., the dispersion may be used to indicate which of these values is correct. Thus the quantum theory of dispersion may be written $\lambda = \delta^{1/2}[\rho/W.e/m.F/2\pi\sum_{1}^{s}N_s\{1 + \log(x^2 - 1)/x^2) - (2\pi q/x^3)\}]^{-1/2}$ where $\delta = 1 - \mu$, ρ the density, W the molecular weight, e/m the ratio of the electronic charge to mass, F the Faraday constant, N_s the number of electrons per molecule of frequency ν_s, $x = \nu/\nu_s$, ν the frequency of the incident radiation, $q = h/\nu_s$, k the damping factor which can be obtained from the atomic absorption coefficient. Precise measurements of the refraction of the copper and molybdenum K series in crystal quartz have been made. Both possible methods of using a prism were used. The 90° edge of the prism was very carefully prepared. The results obtained are given in the following table:—

Method	$\delta \times 10^6$	λ (Dispersion)	λ (Crystal)	λ (Grating)
1	8.553	1.536A	1.538A	1.542A
1	6.971	1.388	1.389	1.392
2	8.560	1.537	1.538	1.542
2	6.976	1.388	1.389	1.392
1 and 2	1.805	0.7089	0.7093	0.7109
1 and 2	1.432	0.6315	0.6314	0.6328

It is difficult to believe that such an agreement between the wave-lengths as determined by dispersion and by crystals is entirely fortuitous. The apparent precision obtained in the ruled grating measurements is so high that the above results must indicate a failure of the optical diffraction theory when applied to X-ray wave-lengths.

E. Backlin (of the Physical Laboratory, Uppsala, Sweden) in the *Physical Review* (1932, *40*, 112-113), in a letter, entitled Absolute Value of X-Ray Wave-Lengths and e/m as calculated from X-Ray Dispersion Measurements, discusses some features of Bearden's observations and mentions that Larsson's density value (ρ) was corrected to a 0.50 per cent. lower figure in Siegbahn's *Spektroskopie der Röntgenstrahlen* (1931). No e/m-value is given in this letter, but from Bearden's statements it would come out higher owing to the above-mentioned correction. See *Chemical News*, 1931, *143*, 41-42, *Phys. Rev.* 1931, *38*, 835-836.—F. H. L.

NEW OCTET EQUATIONS FOR CHEMICAL FORMULÆ.

By ALEXANDER CALANDRA.

A consideration of the relation of the Lewis Langmuir theory of atomic structure to the structural formulas of organic compounds makes possible the derivation of a few simple equations relating structural to molecular formulas.

Langmuir derived the " octet equation." (1).

1. $p = \frac{1}{2}(8n - e)$.

p is the number of pairs of electrons shared.
n is the number of atoms forming complete octets.
e is the total number of electrons in the outer orbits of all the atoms in the molecule.

e.g. Propane C_3H_8 n=3, e=20 p=2.

With few exceptions a single bond in the structural formula of an organic compound represents a pair of electrons shared, a double bond two pairs, and a triple bond three pairs, therefore,

2. $p = s + 2d + 3t$

s is the number of single bonds.
d is the number of double bonds.
t is the number of triple bonds.

The various possible arrangements of the atoms in any molecule provide another equation for p. When the atoms are joined entirely by single bonds and the molecule has no rings, $p = n - 1$.

e.g.

$$\ddot{\underset{\cdot\cdot}{:C}}:\ddot{\underset{\cdot\cdot}{C}}:\ddot{\underset{\cdot\cdot}{C}}:\ddot{\underset{\cdot\cdot}{C:}}$$

Other arrangements are possible but they lead to the same conclusion.

When double bonds are present the equation is modified to $p = n - 1 + d$.

e.g.

$$\ddot{\underset{\cdot\cdot}{:C}}:\ddot{\underset{\cdot\cdot}{C}}:\ddot{C}::\ddot{C}:$$

When triple bonds are present the equation is modified to $p = n - 1 + d + 2t$.

When rings are present the equation is modified to 3. $p = n - 1 + d + 2t + r$.

Equations 1, 2, 3, are combined to yield—

(a) $r + d + 2t = 3n + 1 - e/2$
(b) $s + 2d + 3t = 4n - e/2$
(c) $d + t + s - r = n - 1$

Quinoline.

Structural Formula.	Molecular Formula.
	C_9H_7N n = 10 e = 48

By Inspection—		By Calculation—	
$r + d + 2t$	= 7	$3n + 1 - e/2$	= 7
$s + 2d + 3t$	= 16	$4n - e/2$	= 16
$s + d + t - r$	= 9	$n - 1$	= 9

(*Hydrogen bonds are not counted since they are polar.*)

The application of the above equations is subject to any limitations that may be *imposed on the "octet-equation."* In general they are applicable to all structural formulas where a valence bond corresponds to a covalence bond. This relationship is not true of the structural formulas of diazonium compounds, some oxyacids, and a few other compounds. Langmuir has suggested that the structural formulas of these compounds be modified. In the case of ammonium salts it is necessary to consider the ammonium radical a metal with an electron in its outer orbit.

The maximum number of isomers possible due to the different values that can be assigned to d, t, and r, can be determined from equation (a). When the value for (a) is even this quantity is

$$\frac{(3n + 3 - e/2)^2}{4}.$$

When the value for (a) is odd this quantity is

$$\frac{(3n + 3 - e/2)^2 - 1}{4}$$

The author takes pleasure in acknowledging his indebtedness to Dr. Martin Meyer, of the faculty of Brooklyn College, for his very valuable suggestions during the preparation of this article.

References;

1. Langmuir—The Octet Theory of Valence and its Applications with Special Reference to Organic Nitrogen Compounds. J. Am. Chem. Soc. 42, (274) 1920.

Brooklyn College,
Brooklyn, New York.

ON THE PREPARATION OF A CATALYSER (ALUMINIUM ETHYLATE) FOR THE SYNTHESIS OF ACETIC ETHER FROM ACETALDEHYDE.

By KIYOAKI SUMIYA, SAKAE YAMADA and YOSHIMASA TAJIMA.

In our investigation we used a catalyser solution for the synthesis of acetic ether from acetaldehyde. We now report on some interesting results of our investigation on the preparation of this catalyser solution containing aluminium ethylate.

For the simple quantitative comparison of the amounts of aluminium ethylate, produced by the reaction of anhydrous ethyl alcohol upon metallic aluminium in presence of suitable catalysers, the volume of hydrogen evolved was measured and the quantity of metallic aluminium consumed was calculated from the following equation,

$Al + 3C_2H_5OH = Al(OC_2H_5)_3 + 3H$

The ratio of the value thus calculated to the original quantity of aluminium taken, furnishes the basis of comparison. The term "Utilization of Al" in the following lines means this.

I. Comparison among the various Methods of Preparing Aluminium Ethylate.

The results obtained by comparative experiments on the three outstanding procedures selected from those appearing in literature are as follows:—

Table

Symbol		Shape of Al used	Iodine for Al used (wt. %)	$HgCl_2$ for Al used (wt. %)	Xylene used as solvent (cc.)	Utilization Al (%)
G-Method (1)	A_1	powder (120-150) mesh	100	0	0	84.1
	A_2	,,	50	0	0	82.1
	A_3	piece (1 x 2 x 0.3) mm.	100	0	0	83.6
H-Method (2)	B_1	powder	0	2.0	0	83.1
	B_2	,,	0	2.0	13.0	98.4
M-Method (3)	C_1	powder	1.0	1.0	6.5	96.6
	C_2	,,	5.0	1.0	15.0	97.5
	C_3	piece	10.0	1.0	8.0	99.6
	C_4	,,	5.0	1.0	8.0	99.6
	C_5	,,	1.0	1.0	8.0	95.3

(1) J. H. Gladstone & A. Tribe, *J. Chem. Soc.*, 1876, *29*, 158.
(2) H. W. Hillyer & O. E. Crooker, *Amer. Chem. J.*, 1897, *19*, 37, 597.
(3) Hans Meerwein & Rudorf Schmidt, *Ann.*, 1925, *444*, 231.

In the above experiments except A_1 & A_3, the quantity of anhydrous ethyl alcohol was nearly equivalent to the amount of the metallic Al used. In the case of A_1 & A_3, it has exceeded the theoretical quantity by 50%.

From the above table, the following facts are to be noted:—

1. The combined use of iodine and $HgCl_2$ gives good results.
2. The use of a suitable solvent such as xylene is effective.
3. The quantity of anhydrous ethyl alcohol slightly in excess of the theoretical quantity calculated for the metallic aluminium taken is sufficient for the purpose.

II. Investigation to increase the Velocity of Evolution of Hydrogen.

Although we have found by the above described experiments that, by using aluminium either in the form of fine pieces or powder, aluminium ethylate can be obtained in the almost theoretical yield, the question as to the increase or decrease of the velocity of evolution of hydrogen was not yet answered. In order to clear up this question the authors defined the "average velocity of evolution of hydrogen" by dividing the total volume of the

hydrogen evolved (cc.) by the total number of time required (in minutes) for every 1 gr. of the metallic aluminium taken.

The influence exerted upon this "average velocity" by various causes was studied by the following experiments :—

(1) The process of using iodine, mercuric chloride and xylene.

When, keeping $HgCl_2$ at a fixed quantity (1% of Al), the quantity of iodine was varied from 1% to 5% and 10% of Al, the "utilization of Al" and the "average velocity" above defined, increased from 95.7% and 6.3 to 99.6% and 8.3 respectively. When $HgCl_2$ was excluded in the case of 5% as iodine, the values dropped to 94.7% and 5.6.

(2) Comparison of the processes using $HgCl_2$ and iodine, each in a quantity equal to 1% of Al used, with xylene or acetic ether as solvent.

With the acetic ether, the "utilization of Al" and the "average velocity" are somewhat lower, and a longer time elapses before the actual beginning of the reaction than with xylene. However, when the action has once started, it proceeds very rapidly and smoothly. In this case the combined use of iodine and $HgCl_2$ is indispensable.

(3) Comparison of processes using either anhydrous aluminium chloride (about 10 times of the quantity of Al taken) or anhydrous ferric chloride (about 60% of the quantity of Al taken) alone, in the absence of both iodine and $HgCl_2$, and with acetic ether as solvent.

With $AlCl_3$, the values of "utilization of Al" and the "average velocity" are not very different from those obtained with iodine and $HgCl_2$, whereas, with $FeCl_3$ they are markedly low giving only 21.6% and 1.7 respectively.

In order to increase the "average velocity," the authors used an appropriate quantity of anhydrous $FeCl_3$ combined with $HgCl_2$ and iodine. An example of the improved new process is as follows :—

2 gr. of fine pieces of Al, 0.04 gr. of iodine, 0.04 gr. of $HgCl_2$, and 10.24 gr. of anhydrous ethyl alcohol are taken into a vessel. 10 cc. of acetic ether containing appropriate quantity of anhydrous ferric chloride are added to it and the mixture is heated. After 20 minutes' heating, a further 10 cc. of acetic ether are added. The "average velocity" in this process reached to about the double (16.7) of that of the best result obtained using iodine with $HgCl_2$ alone.

By making the catalyser solution thus prepared to react upon acetaldehyde, the synthesis of acetic ether was accompanied with a very high yield.

[IMPERIAL INDUSTRIAL RESEARCH INSTITUTE, OSAKA, JAPAN.]

NEW ZEALAND KAURI GUM PRODUCTION INCREASES.

The output of kauri gum for the first two months of this year totalled 471 tons which was 32 tons more than the same months of 1931. Reflecting the improvement in production, kauri gum exported from New Zealand during January amounted to 211 tons, an increase of over 50 per cent. over January, 1931. Value increased only 25 per cent., which clearly indicates the present low values ruling for kauri gum, which makes it unprofitable working in many cases.

COD LIVER OIL PRODUCTION IN NORWAY GAINS RELATIVELY.

Production of cod liver oil in Norway during the current season up to April 9, 1932, was reported as approximately 1,934,000 gallons as compared to about 1,134,500 gallons in the corresponding period of 1931. The price of cod liver oil in Norway, based on sales on the Bergen Exchange was 57 crowns per barrel April 9. This price does not include handling charges prior to export and hence is not the equivalent of prices f.o.b. Norwegian ports.

THE USE OF AMMONIA GAS AS A SOURCE OF HYDROGEN FOR THE PRODUCTION OF REDUCING ATMOSPHERES.

By J. R. Gordon, Research Metallurgist, Ontario Research Foundation.

The necessity of maintaining reducing atmospheres to prevent the oxidation of metallic resistors (such as molybdenum at elevated temperatures) and of mercury gaps of induction furnaces results in the consumption of comparatively large quantities of hydrogen in many metallurgical laboratories. The decomposition products of ammonia gas have been used successfully as a substitute for pure hydrogen gas in many cases and at considerably lower cost.

When a stream of ammonia gas is passed over a finely divided iron catalyst at elevated temperatures, the gas is almost completely decomposed to give a gaseous mixture containing 3 parts of hydrogen to 1 part of nitrogen by volume. The reaction of $2\ NH_3 \rightleftarrows N_2 + 3\ H_2$ is regarded as a two-step reaction in which (1) metallic iron and ammonia give hydrogen and iron nitride and (2) the latter decomposes to nitrogen and iron, and the cycle begins again. Ammonia is synthesized from nitrogen and hydrogen in the presence of a catalyst at temperatures between 400° and 500° C., and at pressures between 100 and 200 atmospheres. The reverse action proceeds rapidly in the presence of an iron catalyst at temperatures above 600° C. under normal pressure.

A satisfactory set-up consists of a silica tube filled with steel wool and heated to 600° C. in an ordinary combustion furnace. A cylinder of liquid ammonia supplies the gas, and, in order to ensure the complete removal of ammonia from the hydrogen and nitrogen, the gases from the combustion tube may be passed through a dilute sulphuric acid solution before introduction into the chamber in which the reducing atmosphere is desired. The volume of gas may be regulated readily by the flow of ammonia, and with the equipment described it is possible to obtain volumes of gas up to 50 cubic feet per hour from a 50-pound ammonia cylinder with practically 100 per cent. conversion of the ammonia into nitrogen and hydrogen.

This equipment is easily set up, and can be assembled from standard parts, such as are to be found in any laboratory. The total cost of the apparatus need not exceed $100, at a very liberal estimate. The steel wool catalyst is inexpensive, and needs replenishing at only very long intervals.

Canadian Chemistry and Metallurgy.
April, 1932.

POTASH FROM SUNFLOWERS IN RUSSIA.

The manufacture of potash from the ash of sunflowers was carried on in Russia as far back as the sixteenth century. It was produced in considerable quantities, averaging about 20,000 tons annually, before the world war. The main centres for this type of potash are in the Caucasus and the Ukraine, where sunflowers are cultivated on a large scale. It is free from iron and contains a negligible percentage of sodium salt. Until recently, production was carried on in a rather primitive manner, but in 1930 two large plants with modern equipment started operations. Through the discovery of large deposits of mineral potash in the Urals in 1926, Russia now ranks as the world's second largest potash producer. ("Economic Review of the Soviet Union.")

NEW REFRIGERANT MIXTURE.

I. G. Farbenindustrie in Germany have developed a new refrigerating mixture, arising out of the demand for operating at low temperatures in the laboratory or in industrial processes. A mixture of one part of solid carbon dioxide with four parts of chlorsulphonic acid permits of the attainment of a temperature of —45° C., and a mixture of these two constituents in equal quantities gives a temperature of —70° C.

BUSINESS CONDITIONS IN CANADA.

Preparations for the coming season's agricultural operations will soon be under way in practically all sections of Canada. Weather conditions in the Prairie Provinces during the past winter have generally been normal and snowfall was sufficient to ensure adequate moisture supplies in most districts. The drought areas in Southern Saskatchewan and the adjoining sections of Manitoba and Alberta, however, report that unfavourable conditions still prevail, and in these districts heavy spring rains are required to put the soil in good condition for seeding.

The demand for wheat from importing countries is more active. The French Government has raised the foreign wheat quota allowed millers a further five per cent. making the total forty per cent. This is higher than the maximum allowance last season, when the quota was finally raised to thirty per cent. in June. Decreases were made beginning with July to provide for the disposition of the domestic crop. Italy has lowered the barriers against foreign wheat, allowing southern mills to use seventy per cent. and northern mills fifty per cent. Germany has reduced her tariff on foreign wheat and is also considering the modification of milling regulations to enable the importation of some 14 million bushels of wheat. Famine conditions have been reported in some sections of Russia and further exports of wheat this season are not anticipated. Fall sowings of winter wheat were made over a larger area but difficulty is being experienced in securing seed for spring sowings and a reduction in acreage may be expected if present conditions continue. World stocks of wheat are still large but indications point to a substantial reduction in the carryover before the coming crops are harvested. With improved demand and adequate moisture supplies, the western farmer is entering the new season under more favourable conditions than have prevailed for some time.

Livestock on farms are generally in good condition, the mild open winter in Eastern Canada being of great assistance. Less grain feed has been required than usual and animals have had more opportunity for exercise. Exports of cattle to Great Britain have continued in satisfactory volume, fortnightly shipments being made from Saint John. There has also been a keen demand for high grade dairy cattle from the United States.

Production of creamery butter in Canada in 1931 is estimated at over 227,000,000 pounds, an increase of 41,425,000 pounds over the output in 1930. The 1931 total constitutes a new record for the Dominion. Ontario produced 75,000,000 pounds, an increase of 15 per cent., as compared with 1930; production in Quebec is placed at 70,000,000 pounds. Increased interest in dairying was shown in the Prairie Provinces during the past year and new records in butter production were made in all three provinces. Output in Canada generally has shown the usual seasonal decline during the winter months but returns indicate that operations have been maintained at a higher level than in 1931. Some butter has already been sold for shipment to England. Export sales so early in the year are unusual and a good year is anticipated in this trade, which was revived in 1931 after a lapse of several years. Total shipments to England last year amounted to 8,657,000 pounds, compared with 11,700 pounds in 1930. Total exports of butter from Canada in 1931 amounted to 10,680,500 pounds against 1,180,400 in 1930.

Conditions in the manufacturing industry are still poor, although some improvement in operations has been reported in a number of lines. The textile and allied industries are the bright spots in manufacturing and mills generally are busy, with some overtime work. Agricultural implement plants have increased production and additional men are being employed. Work on new automobile models has commenced but output is being restricted to current requirements. Some hesitancy has resulted from the delay in the introduction of the new Ford models. It is expected, however, that production will gradually be increased as the season advances, but the peak in

operations will be reached much latter this year than usual. The iron and steel trades report business dull but some improvement is anticipated. The Dominion Steel and Coal Company recently commenced operations at four furnaces in the open hearth department at the steel plant, which had been idle for two months. The bloom and billet mills were also brought into operation, and later the wire and nail mills were added to the active units. The Algoma Steel plant and rail mill have also resumed operations after having been closed for some time. Boot and shoe factories continue active; production has slackened slightly but returns show increased production for each month since February, 1931, over the corresponding month of the previous year. The manufacturing industry generally, however, is operating on a reduced basis and production is being curtailed in many important branches.

The production of gold in north-western Quebec during January was the highest recorded so far in the history of this field. The output was valued at $642,382, against $525,783, in December. Noranda's production was valued at $485,000, a substantial increase over the two preceding months; Siscoe produced $124,000, a new monthly record; Granada is now using hydro-electric power and continued expansion is expected at this property. The total output of Ontario's gold mines in February was valued at $3,606,966, as compared with $3,682,708 in January. Production, however, was $374,744 greater than in February, 1931. Ore in the Porcupine camp was of higher grade than in January, value recovered showing an increase despite a decrease in tons of ore milled. Manitoba is gaining prominence as a gold producer and now has four mines actually shipping. It is expected that a fifth, San Antonio, will soon be added. Milling machinery for the Amisk Lake Gold Syndicate is being shipped to its property at Amisk or Beaver Lake in northern Saskatchewan. British Columbia also reports continued *activity in gold mining. The Premier* mine is producing gold at the rate of $60,000 to $70,000 per month. The capacity of its mill is being enlarged from *100 tons to 300 tons* daily and output will be substantially increased. The Lorne Mine has completed a 100-ton mill and is now on a production basis. Other branches of the mining industry are not so active and low prices have resulted in greatly restricted operations. The demand for coal has been slow and output has been reduced accordingly. Equipment and supplies are being sent in to the Great Bear Lake district and active developments of silver and radium bearing deposits are anticipated in this area during the present year. Exploration and prospecting work is being pushed forward aggressively in many widely separated fields and interesting developments are expected.

Construction work continues slowly, contracts awarded in January and February showing slight increases over previous months but the total is much less than for the corresponding months of 1931. The development of water power sites continues, actual installations during 1931 amounting to 546,650 horse power. This represented the completion of undertakings which have been under construction for some time, but it is estimated that capital expenditures totalling $110,000,000, were made during the past year. Other projects now under way will, it is anticipated, add a further 1,400,000 horse power, increasing the present total installation of 6,666,337 horse power to more than 8,000,000 horse power by the end of 1934. Capital expenditures required to bring these projects to completion are estimated by the Dominion Water Power and Hydrometric Service at $280,000,000. The demand for power has shown some decline due to the depressed business conditions prevailing during the past two years, but it is expected that as improvement sets in, the demand for power throughout the Dominion will absorb the available supplies.

Conditions in the lumbering industry are quiet; woods operations have been generally curtailed and the cut will be small. Stocks are at a very low level, *however, and prices are slightly firmer.* Operators are hopeful that the imposition of the new British tariff on foreign lumber will be beneficial to the industry,

but it is by no means clear that the preference is substantial enough to prevent serious competition from Russia.

Fish export markets have been depressed and demand poor. Operations are being curtailed and it is not anticipated that the Lunenburg fleet will sail on what are known as the first and second trips. Maritime stocks of fish are low and will probably be disposed of before arrival of new supplies.

Plans for this year's operations in the canned salmon industry are still incomplete, but in view of the large stocks of the cheaper grades still unsold, it is understood that fishing will be more or less restricted to the "sock-eye" areas. The preference accorded to British Columbia canned salmon under the new British tariff means much to the industry.

RUST AND CORROSION OF STEEL.

A NOTABLE PAPER.

(By a Well Known Engineer.)

At the recent 83rd Convention of the American Chemical Society at New Orleans, Dr. Gustav Egloff, the well known petroleum authority, read a paper on the subject of the huge losses caused by corrosion. He estimated that in the United States alone the corrosion of metals is resulting in a loss of more than $1,000,000,000, (£200.000.000) per annum. Also he states that on a conservative basis rust and corrosion is costing the American oil industry over $125,000,000 (£25,000,000) per annum, equivalent to a levy of 1 cent (½d.) on every gallon of petrol, apart from the $100,000,000 (£20,000,000) spent every year on paint and other protective material.

There is emphasised also the well known facts that a vast army of research workers are engaged on the subject of rust and corrosion, and that all kinds of methods are in use to try and protect iron and steel, including coating with non-oxidisable metals, ceramic materials, and bituminous coverings. The widespread use of rustless and stainless alloy steels, of the nickel, chromium, and molybdenum varieties for example, cannot of course be carried out because of the high cost, and the main remedy is painting.

Also the American petroleum industry, which resembles the chemical industries in the sense of having a large amount of exposed plant and equipment has found that much improved protection against corrosion is given by using high grade paint. In this connection it has long been known that one of the most valuable methods for the protection of iron and steel is the application of Red Lead paint, and every description of steel structure is being protected on these lines, including gasholders, oil tanks, lighthouses, docks and harbours, bridges, and pit-head gear for example, and in many cases the steel is in perfect condition even after 40 50 years, because of the regular use of such paint. Also largely for this same reason any serious corrosion of ship's hulls in constant contact with sea water is now practically unknown.

Modern developments in the manufacture of Red Lead have resulted in the production of a pigment containing not less than 94 per cent. Red Lead (Pb_3O_4) Plumbic Tetroxide, and 99½ per cent. total oxides of lead, with not over 6 per cent. Lead Monoxide (PbO). Excess of the latter causes the setting or hardening of the paint on storage in the usual containers, but the mixing of small lots at a time of Red Lead and oil is therefore no longer necessary.

On the subject also of the losses caused by the rusting and corrosion of iron and steel it will be remembered that Sir Robert Hadfield in his well known paper "Corrosion of Ferrous Metals" read before the Institution of Civil Engineers ("Proceedings, Vol. CCXIV, Session 1921/2, Part 2, Published in 1923) estimated the total figure at the gigantic total of £700,000,000 per annum for the world, based on an average value of about £20 per ton for steel as the finished structure.

MALAYAN IMPORTS OF CHEMICALS, DRUGS AND DYES.

The value of chemicals, drugs and dyes imported into Malaya during 1931 totalled $11,509,797, as compared with $15,693,831 in 1930.

Proceedings and Notices of Societies.

SOCIETY OF PUBLIC ANALYSTS
AND OTHER ANALYTICAL CHEMISTS.

Wednesday, May 4, The President, Mr. F. W. F. Arnaud, in the Chair.
The following papers were read:—

The Separation of Tantalum, Niobium, Titanium and Zirconium, and a new Analytical Grouping. By W. R. SCHOELLER, Ph.D., and A. R. POWELL.

The authors' recent method for the separation of titanium from zirconium, based on precipitation of the titania as tannin complex from the nearly neutralised oxalate solution half-saturated with ammonium chloride, has now been proved to afford a quantitative separation of tantalum, niobium, and titanium ("acid tannin group") from zirconium, thorium, and aluminium ("basic tannin group"). Under the conditions realised by the procedure, tannin acts as a group reagent precipitating any or all of the members of the acid tannin group, thus separating them from any or all of the members of the basic tannin group. The inclusion of certain other metals (*e.g.*, uranium) in the last-named group is being investigated.

The Iodine and Thiocyanogen Value of Irish Butter. By P. S. ARUP, M.Sc., F.I.C.

The iodine value of Irish butter fat rises from May to October and then falls again, owing mainly to the influence of the winter feeding factor. The thiocyanogen value (affording a measure of the linolic acid) is higher in winter than in summer, indicating a tendency for the linolic acid to increase as the oleic acid decreases. The proportion of linolic acid in the unsaturated fatty acids in Irish and foreign butters ranged from 9.1 to 13.2 per cent.

Sediments in Ink and in Writing. By C. AINSWORTH MITCHELL, D.Sc., F.I.C., and T. J. WARD.

The causes of the formation of sediments in inks and their identification in writing have been studied. The effects of excess of iron, of tannin, and of gallic acid are clearly indicated. Among the external causes producing sediments recognisable in writing are alkali in glass, moulds, and extraneous substances such as dust, vegetable débris and starch, and the evidential value of such deposits is discussed. A new method of detecting oxidase in moulds, etc., has been based on the acceleration of the oxidation of a solution of tannin and ferrous sulphate by the substance containing the oxidase, the resulting precipitate of basic ferric tannate being collected and weighed.

The Determination of Minute Amounts of Copper in the Presence of Iron and certain other Metals. By L. G. HADDOCK, B.Sc., and NORMAN EVERS, B.Sc., F.I.C.

It is shown that the separation of copper from iron by means of ammonia or hydrogen sulphide is incomplete. An accurate method consists in keeping the ferric iron in solution by addition of citric acid and ammonia, adding sodium diethylthiocarbamate (Callan and Henderson), extracting the solution with carbon tetrachloride (Grindel), and measuring the colour of the extract in a tintometer, or comparing it with standards containing known amounts of copper. As little as 0.005 mgrm. of copper may be detected in the presence of 0.25 grm. of iron.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND, MAY 4th, 1932.

Chemical Committee.

Mr. H. DENT BROCKLEHURST, in the absence of Mr. Fred Smith (Chairman), reported that the list of samples analysed for members during the month of April, 1932, had been submitted to the Committee.

Dr. Voelcker had reported upon the proceedings at the recently held meetings of the Advisory Committee of the Ministry of Agriculture on the Fertilisers and Feeding Stuffs Act, 1928, and the decisions then arrived at. These would, in due course, be laid before Parliament for their approval previous to their passing into law.

Dr. Voelcker had also mentioned points of interest which had arisen in the course

of the examination of soft waters in connection with their action upon metals and of hard waters treated by softening processes.

In the last report reference had been made to a sample of ground lime found to contain a considerable part of the limestone still in the unburnt state, and to have damaged to some extent the drill used in distributing it. It should now be reported that, on representations being made, the merchants acted very honourably in the matter, admitting the error, and compensating the purchaser fully for inferiority of quality and damage to the drill.

ROYAL INSTITUTION.

A General Meeting of the Members of the Royal Institution was held on Monday afternoon (May 9), Sir Robert Robertson, Treasurer and Vice-President, in the Chair. Sir Joseph Thomson was re-elected Honorary Professor of Natural Philosophy, and Lord Rutherford of Nelson was re-elected Professor of Natural Philosophy. Mr. H. E. Cox was elected a Member.

Correspondence.

To the Editor, *Chemical News.*

SIR,

Whoever goes out to represent this country at Ottawa will almost certainly be struck by a curious development amongst all classes of workers, from the engineers and stokers on the C.P.R. lines to the scavengers on the Canadian roads. Whole groups of Canadians who earn their livelihoods by their hands are now wearing gloves, usually of rubber or rubberised fabric. Engine drivers, road makers, railway porters, farm workers have all adopted the new fashion.

It is an insurance against occupational dermatitis (eczema) which in most cases begins on the hands and arms and spreads over the rest of the body. What is the incidence of this painful industrial disease amongst those who handle sugar, flour, dyes and so on? If it be as considerable as the general statistics indicate Canada's lead is one which we might very well follow.

Yours, etc.,
M. D.

May 7, 1932.

Notices of Books.

Modern Methods in Quantitative Chemical Analysis, by Dr. A. D. MITCHELL and Dr. A. M. WARD. Pp. xii + 178. London: Longmans, Green & Co., 39, Paternoster Row, E.C., 1932. Price 6s.

In this admirable book the authors have brought together a number of new, but tried and successful methods for the quantitative estimation of the majority of the chemical elements and, in addition, the less easily determined acid radicles and a few common organic compounds.

The methods selected are those which most closely fulfil the following requirements; (1) if involving the use of a Gooch crucible, they should preferably be adapted to the new pattern having a sintered glass diaphragm; (2) they should not depend upon a narrow range of empirical conditions or upon standardisation under identical conditions; (3) they should be capable of effecting useful separations, and not be of academic interest alone, and (4) the necessary reagents should be readily obtainable.

Whilst each method is complete and contains adequate details for the carrying out of any estimation recorded, a brief bibliography is given at the end of each section for those desiring to consult the original literature.

Quite a number of the methods given were only published within the last two years and include Geilmann and Weibke's method for separating molybdenum from rhenium and their nitron process for estimating the latter. By including methods for titanium, tungsten, vanadium, etc., the authors are assisting in dispelling the notion that these are still rare elements. Quite a number of the methods are new to the reviewer and it is certain that the majority of chemists will find much worthy of their careful attention. The processes given will almost certainly supersede the older ones hitherto in vogue.

L'Atomistique Moderne et la Chimie, by M. HAISSINSKY. Pp. vi + 386. (Collection Langevin-Perrin-Urbain). Paris: G. Doin, 1932. Price 110 francs.

This volume, the preface to which has been written by Prof. Langevin gives a very good account of the history and recent developments of the atomic theory and its subsequent extension as knowledge of the structure of the ultimate particles of the elements has extended.

The periodicity of the elements is discussed from the standpoint of modern knowledge and there are important chapters on the Bohr atom, nuclear structure, isotopes, Kossel's electrostatic theory of valency, Born's theory and its applications, photochemistry, catalysis, etc.

The book contains more than its title suggests since it includes much of modern physics, especially as regards the treatment of the sections on radio-activity, thermodynamics, energy, quanta and the electronic theory of matter.

Les Problemes de la Biochimie Moderne, by Prof. G. Florence and Dr. J. Enselme. Pp. 312. Paris: G. Doin, 1932. Price 45 francs.

The present is an opportune time to take stock of the progress recently made in biochemistry and to examine current difficulties and the main problems awaiting solution.

Biological chmistry, which has developed from the organic chemistry of natural products, has made such rapid strides since the war that only specialists have been able to keep pace with the modern tendencies. One has only to mention the latest ramifications of colloid science to bring to mind the greatly extended range of knowledge available for application to the pressing problems associated with plant and animal life. At present little more than a beginning has been made in the direction of correlating chemistry and physics with biology.

The present book, to which Prof. Hugounenq, doyen of the medical faculty at Lyons, has contributed an able preface, is divided into sections dealing respectively with *les molécules biochimiques, biochimie cinétique* and *chimie physiologique.* The first part includes a description of certain physical and chemical phenomena applied to biology and an account of the various groups of organic compounds associated with plant and animal metabolism.

The second section is devoted to the mechanism of chemical changes in the living organism or through its agency, whilst the third part covers the usual ground of physiological chemistry together with a discussion of the problem of immunity. This valuable contribution to the literature of biochemistry and its borderland is commended to the attention of organic and biochemists and also to the medical profession.

J. G. F. D.

Das Waagtal, by Charles Benyovszky. Pp. 100. Bratislava: S. Steiner, 1932. Price 12 Czechoslavak Crowns (2s.).

Mr. Charles Benyovszky has already written interesting books on Bratislava (or Pressburg as it is called in German), the capital of Slovakia, *i.e.,* eastern Czechoslovakia. He now gives an interesting account of the picturesque valley of the Váh or Waag. He is chiefly concerned with the natural characteristics and beauties of the country through which this tributary of the Danube flows but he does touch upon the history, industries and characteristics of the places of interest which lie between the Danube and the High Tatras. For scientific readers the descriptions of the spas and thermal resorts are also not without interest. This work in German is a welcome addition to the already extensive literature on Czechoslovakia.

New Patents.

These particulars of New Patents of interest to readers have been selected from the Official Journal of Patents and are published by permission of the Controller of H.M. Stationery Office, and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

Latest Patent Applications.

11,895.—Ros, D. de.—Production of hydrogen, etc. April 25th.

Specifications Published.

371,377.—Roman, L. H.—Process for manufacturing formaldehyde from gas containing hydrogen and carbon monoxide.

371,621.—Mentzel, A.—Production of sodium carbonate and ammonium chloride.

Group Abridgments can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, either sheet by sheet as issued on payment of a subscription of 5s. per Group Volume or in bound volumes price 2s. each.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, at the uniform price 1s. weekly.

Abstract Published.

366,737.—Ammonium, calcium, and potassium phosphates; ammonium and potassium nitrates.—Kali-Forschungs-Anstalt Ges., 5, Schonebergerstrasse, Berlin.

A fertilizer is produced by dissolving potassium sulphate in nitric acid and mixing the solution with finely pulverized crude phosphate, so much dry finished product being also added to the reaction mixture that a solid friable product is obtained. The potassium sulphate may be replaced in part by ammonium sulphate.

The Latest Trade Marks.

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of H.M. Stationery Office, and the Trade Marks Journal can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

RED DIAMOND.

527,018.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes, but not including disinfectant soap.—Burgoyne, Burbridges & Company Limited, High Street South, East Ham, London, E. 6. May 4. (Associated.) (By consent.)

530,536.—A triangulated label device illustrating a pyramid, the sun and its rays and a part of a circle.—Chemical substances used in manufacters, photography or philosophical research and anti-corrosives. —Tex Campbell & Co., Limited, 7, Idol Lane, Eastcheap, London, E.C. 3. May 4.

THE CHEMICAL NEWS

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PRESENT DAY TRENDS IN THE STUDY OF THE STRUCTURE AND NATURE OF THE UNIVERSE*

By H. W. BLOOD RYAN, M.A., D.SC., LL.D., PH.D.

President of The Faculty of Sciences, and a Vice-President of the Muslim Association for the Advancement of Science

A really exhaustive study of all matters relating to the structure and nature of the Universe calls for a most versatile mind and a particularly broad training. Consequently, to-night, I shall just skim the surface here and there, else the Faculty would be required to take a permanent lease of this building and my hearers would require several injections of rejuvenation treatment.

In dealing with such a subject as the title of this paper, I am reminded of a story attributed to Oliver Wendell Holmes. Upon being asked what particular chair of learning he held in his University, he replied, "a chair, why I don't occupy a chair, I have a complete balcony." As in those days, a professor was required to be sufficiently versatile to undertake instructional work in faculties other than his own, so now in these days it is more than ever necessary to possess much more knowledge than is essential to one's daily occupation.

But that knowledge has not always been easy to obtain. America is more fortunately situated than are we here in England, in respect of well-endowed research institutions. Such bodies as the Rockefeller Trust, The Chemical Foundation, Franklin Institute and Mellon Institute come readily to the mind. Only the outspoken speeches of Sir Oliver Lodge and Sir Douglas Galton caused the Government and the public to found the National Physical Laboratory at Teddington. In his Presidential address to Section A (Mathematics and Physics) of The British Association for the Advancement of Science at Cardiff in 1891, Professor (now Sir Oliver) Lodge took the oppor-

* A Lecture delivered before the Faculty of Sciences in London, on the 24th May, 1932. The Marquis of Tavistock in the chair.

tunity to "call attention to the fact that the further progress of physical Science in the somewhat haphazard and amateur fashion in which it has been hitherto pursued in this country is becoming increasingly difficult, and that the quantitive portion especially should be undertaken in a permanent and public-supported physical laboratory on a large scale." Then came the Teddington effort, which has proved of inestimable value to the country and to Science.

The study of the natural sciences, effects humanity in two different ways. It offers intellectual exercise and yields, through fruitful labours, some of our material wants.

A very rich harvest has come in the train of those, who, in the past and in the immediate present, have devoted attention to the study of physical phenomena. The physicists of our day, however, have reached a higher degree of practicality, than did those of earlier times, due in the main, to profiting by a study of faulty hypotheses of the past and finding wherein lay the fault, and by the use of more accurate scientific data and instruments.

Voltaire said, "the methods of arriving at error are innumerable, whilst there is but one way that leads to truth, it is therefore the odds of infinite to one, that a Philosopher, who supports his principles only by Hypotheses, will advance nothing but Chimeras. Hence, it is, that all the Ancients, who have treated Physics without the light of Experiments, have been only the Blind explaining the Nature of Colours to the Blind."

Einstein is the last and, to us, the most important of a long line of great thinkers who have mapped the place of our world, and the importance of human life, in what we know to be, our Universe.

Tolman, whose work I will mention towards the close of this paper, is another giant of thought in our new system of physics who bids fair to out-Einstein, Einstein.

The succession of Great Thinkers may be ordered thus:—

Pythagoras ...	569—470 B.C.
Ptolemy	130 A.D.
Copernicus ...	1473—1543
Galileo	1564—1642
Kepler	1571—1630
Descartes ...	1596—1650
Newton	1642—1727
Michelson ...	1852—1931
Einstein	1879—

It can definitely be asserted that our present day comfort, with easy method of travel and speed of inter-communication, owes its existence more to physics than to any other branch of science. Even now these methods are constantly subject to change and improvement and I can see no slacking off of the progress in these fields—in fact the range of activities is increasing, quite apart from the improvement of existing plant and methods. There are some who rail against the introduction of new devices and methods—that profound alterations in our social welfare have been brought about to the detriment of the lower grades of our present-day society. Be that as it may, there can be no denying that the stupendous social and political developments that have characterised the last two decades have been rendered possible only by the present-day position of applied science.

I am not concerned here with the sociological implications involved in our present-day conditions—whether man's new powers over nature have come to him at a greater pace than his wisdom of judgment allows—whether the progress of invention should mean less time spent in wresting from life a living and greater leisure to cultivate knowledge and enjoy pleasure—such arguments are for other and more powerful platforms—but, before I pass on I will say that the function of science is not to work for the benefit and aggrandisement of the few, but for the welfare and comfort of the many.

The progress of pure science has been no less than that of applied, in fact such progress has been so rapid, many ideas being nothing short of revolutionary, that physicists are, at the moment, hard put to, to keep apace of the flood of literature recording ideas and experiments.* By analogy the situation in

physics is somewhat like an advancing army that has met with stiff resistance—suddenly the enemy front weakens and breaks and the victors leap through,—only to find that their numerical strength is insufficient to garrison the occupied territory.

Pure science has discovered in the theory of relativity a new truth—and, treating it like a religious creed—can it realise and understand all the implications? The path of relativity is a slippery one—if the ideas of relativity were self-evident or if they could be grasped without effort, the theory would evidently not be sufficiently novel to deserve much thought and consideration. Fundamentally, relativity involves a new method of thinking of the ordinary concepts of physical science. The revolutionary ideas are so different from those to which we have become accustomed that upon first meeting with them one experiences much confusion of mind. Anyone, who expects to grasp the significance of relativity in one lecture or by the reading of a single popular book will be sadly disillusioned and most certainly discouraged. Clarity of perception requires the reading and re-reading of books at intervals sufficiently far apart as to allow time for the new ideas to become incorporated as a part of one's mental equipment.

To me, at first, the study of relativity was something akin to the mental perambulations I performed during my study of Metaphysics.

First the Universe was part of my mind—then my mind was a part of the Universe—yet the Universe which was part of my mind and the Universe of which my mind was a part were one and the same Universe for all valid thinking. There was a time when I thought, as many have done and do, that the Universe was real and my mind an illusion; then I turned to the Italian theory, that my mind alone was real, and the Universe illusory; because if anything is real—I am. then I came to think with the Kantian dualists—that the Universe and my mind were both made up of things as real as I was and that only the partition was illusive. Now it is not possible to reach such a conclusion by pure thinking. Circumspection and experiment were needed to solve it and this must be made by other means than words alone afford. So it is with new theories in physics; let us not forget Voltaire's words concerning the Theorists.

Because of the complex nature of physics, one would have imagined that the layman—ever busy with his everyday work—upon hearing of these new ideas such as relativity and the quantum theory, would have waited until such time as they had been correctly presented to him in a form capable of easy assimilation. But no—so startling was the theory of Einstein, challenging as it did our ordinary ways of thinking—that it compelled universal attention immediately consequent upon its first announcement. The world lay-press seized upon it as a subject for flaring headlines—at first it caused amusement—then, upon the theory being accepted by those competent to judge and its implications superficially realised, came a craze for a study of this intriguing idea. Many whose interest had up till then, been in anything but physics, sought each day for fresh news and enlightenment. But here came the obstacle—it unfortunately happens, that mathematics enters largely into the study of the subject and those who set out to present a popular explanation are seriously handicapped. Because of this also, all the elementary books on relativity present only a meagre account of the grounds for belief in the theory, consequently, the unskilled in the manipulation of higher mathematics, after a perusal of such a book, is not convinced as to the main issue and after reading on, is confronted by such a series of the most alarming paradoxes, that he either rejects the whole matter as an insult to his intelligence or lays the book down with a sigh, as being a batch of nonsense.

This state of mind, it can be seen, is brought about by neglect of a branch of learning hitherto thought unnecessary to existence (except in certain professions) or by lack of understanding and sympathy with the expositor.

So it was in the days of yore. The ancient philosophers and astronomers were scorned and their views rejected because of that lack of knowledge and ability to perceive the march of progress.

Many, many times in days long gone the teachings of physics have seemed to conflict with the verdict of then-known knowledge and the minds of mankind.

It must have been terribly difficult for the idea to become acceptable, that the earth was not a flat surface, but a round ball, poised in space.

It must have appeared extremely difficult for the people of that period to appreciate such a statement. Many queries I am sure presented themselves, upon meditation—why did not everything fall away from the under side of this ball and how was the ball supported? Pythagoras is credited with being the first to teach the spherical theory of the Earth and several Greeks of that period made surprisingly accurate calculations of the Earth's circumference, notably Eratosthenes (about 250 B.C.). Except among the Greeks, it is probable that no other nation of that and following periods knew that the Earth was round. It is further highly probable that until the world had been circumnavigated, the fact was not common knowledge.

The view that the Earth revolved around the Sun and not *vice versa* was equally difficult of acceptance. In those days it outraged normal thinking to suggest that the apparently motionless Earth was rushing around at a tremendous pace—what was worse, especially in the eyes of theologians, which class it must be remembered then held a monopoly of learning and its dispensation—the theory so subordinated man's importance in relation to the other stars and planets, as to be rank heresy to give utterance to such views.

As a natural outcome there arose conflict between new discoveries and accepted beliefs. So it has always been and will be till the end of time. Yet, ultimately, in the case of each new discovery, we find the new harmonising with the old.

The real beginning of our difficulties in modern physics may be traced to the abandoned corpuscular theory of light. Newton accepted this theory only because of the then apparent impossible task of reconciling the idea of wave motion with the more acceptable fact of the rectilinear propagation of light. This objection was overcome by Young, who placed the wave theory in an apparently unassailable position. But, it became urgently necessary to consider the nature of the medium which allowed the waves passage, so a search was commenced for the light carrying vehicle.

Dr. J. R. Milne, Lecturer in Natural Philosophy in the University of Edinburgh, in a recent lecture in that city, has ably set out the nature of this search.

The search for a luminiferous ether thus begun has lasted until almost the present day; it has occupied the energies of some of the most famous physicists; and it has constituted the greatest and most formidable problem of its time. Such a medium must not only fill the whole of interstellar space, but must possess the remarkable property of offering no appreciable resistance to the movement through it of all material bodies.

The question thus naturally arose, was the earth in its motion round the sun exposed to an "ether wind" blowing over its surface at some nineteen miles per second, or was the layer of ether immediately in contact with the earth's surface carried along by the earth, in much the same way as the particles of water clinging to a ship's hull are carried along by the motion of the ship. An answer could apparently be found by measuring the velocity of light between two points on the earth's surface taken in the direction of the earth's motion.

If the velocity were the same, regardless of whether the light were sent backwards or forwards along this line, then the ether must be carried with the earth. If on the contrary the two velocities are found to differ, then half this difference is equal to the speed of the ether wind. Unfortunately the experiment cannot actually be carried out because of the difficulty in measuring the speed of light with the required accuracy.

As the velocity of the earth in its orbit is some 30 kilometres per second while that of light is 300,000 kilometres per second, the ratio of the one to the other amounts to no more than one part in ten thousand.

In 1881, however, a modification of this experiment was attempted by the late Professor A. A. Michelson, one of America's greatest scientists. In fact, Michelson right down to his death last year, was ever seeking means to further verify his results obtained. The work of Michelson has now been accepted as a classical example and his results, a constant, in physics. For years he toiled until success rewarded the efforts of himself and a colleague, one Morley, culminating in their famous paper in the Philosophical Magazine in 1887. Their work is now known as the Michelson-Morley experiment. One writer expresses it as a race between two rays of light in two directions in order to discover which would win. Actually the experiment was as follows:—

Two beams of light, starting from a common point, were directed for equal distances, in directions mutually at right angles and were returned by means of fixed mirrors to the point of emission, any discrepancy in the time of return being measured by an interferometer. Now some difference in the time of return was anticipated, because one beam was placed in the direction of the Earth's motion and the other across it. This difference in time was, at that period, a thing beyond doubt, since the polar axis of the Earth, while moving in its orbit, always occupies parallel positions, the orbital velocity of 18.6 miles per second taking place from west to east, and no velocity in the north and south direction.

But, contrary to expectations, no difference was found. The result of the experiment showed, therefore, that the ether at the Earth's surface has no motion relative to the Earth. This conclusion of the two American physicists was so difficult to account for (and because, probably, of their probity in matters physical), that it attracted universal attention. Consequently many famous scientists repeated the experiment, varied sometimes in method, but with the same negative outcome.

The scientific world, for the most part looked upon this experiment as a failure. Why did it fail? The brilliant Irish physicist, Fitzgerald and the celebrated Dutch physicist, Lorentz, both came forward, independently with an explanation, namely that all bodies when in motion through the ether are shortened in the direction of movement. The idea at first blush appeared incongruous, but two points must be remembered. Firstly the amount of necessary shortening is extremely small—practically negligible—scarcely some three inches of the diameter of the earth; and secondly as everything will be affected by the same cause and in a similar manner, the result becomes undetectable by any method of comparison.

By the time Fitzgerald and Lorentz put forward their similar, but independent, explanations, it was commonly known that all matter is electrical in origin and as the force between electric charges has its seat in the ether, it was possible for them to construct an argument to support their views concerning the hypothetical shortening, which argument they translated into formula and which is now known as the Fitzgerald-Lorentz contraction.

About ten years after this suggestion had been given to explain the failure of this brilliantly skilful attempt to measure the absolute motion of the earth, in 1905, a young man named Einstein put forward his special theory of relativity, in which he viewed the Michelson-Morley experiment, not as a failure, but as a brilliant success. The first principle of relativity, which he deduced from the experiment, now so differently regarded, stated that absolute motions, with the single exception of the velocity of light, were impossible to measure or even to detect; that the observed motion of the Universe were all of relative nature.

The Michelson-Morley experiment was a decisive demonstration that any attempt to detect absolute motion would invariably be frustrated by the very nature of the interrelationship of matter and space, unless by some magical wand, one could go out into space and make measurements by observing the earth hurling past one with its velocity of 18.6 miles per second. So we find that instead of being regarded as the most conspicuous of a series of failures to attain a purpose, the experiment is now established as one of the foundations of the new system of the Universe.

Before leaving this interesting point I feel it necessary to mention the difference in

length of the two paths of light when the apparatus (in this case the Earth) is in motion. It is measured by terms involving the ratio $\frac{V^2}{C^2}$, where V is the velocity of the Earth, and C is the velocity of light. When the terms are squared, as they are in this case, it is known as a "second order" effect. Now James Bradley (1692-1762) who was for a while Professor of Astronomy at Oxford and later became Astronomer Royal, back in the sixteenth century had attempted to measure the velocity of light, by methods more natural than instrumental. He evolved the ratio $\frac{V}{C}$ which would be a "first order" effect. How the exactness of our measurements have changed will best be illustrated, naturally, by a comparison. The difference between effects of the first and second order may be shown effectively by inserting in the two expressions the numerical values.

We then have:—

Bradley.

$$\frac{V}{C} = \frac{18.6 \text{ miles per sec.}}{186{,}000 \text{ miles per sec.}} = \frac{1}{10{,}000}$$

Michelson.

$$\frac{V^2}{C^2} = \frac{(18.6)^2}{(186{,}000)^2} = \frac{1}{100{,}000{,}000}$$

The Ratio of Bradleys of one to ten thousand is quite small and may be easily measured; the ratio of Michelson's is extremely smaller and far greater difficulty is experienced in measuring. When it is measured, however, it reveals very minutely the relation of the phenomena of nature to one another.

The Michelson-Morley experiment was the first real attempt to measure directly a second order effect of this kind, and for this reason it occupies an important and fundamental position as part of the basis of the special theory of relativity.

Other experiments, also capable of measuring second order effects, have since been devised, one even as recently as 1931, and started under Michelson's direction just before his death, but in every case but one, they confirm the negative or rather I should now say, the positive results first obtained by Michelson and Morley. The exception is the case of Dr. D. C. Miller, who several years ago repeated the experiment at several altitudes, including the summit of Mount Wilson in California. He asserts that, contrary to the previous results obtained, measurable velocities of the Earth relative to the ether were found, increasing in magnitude with the height at which the experiments were made. The velocities obtained by Miller, while being too large to be completely ignored, are yet too small to be of any real significance in convincing those who have given intensive study to the theory of relativity, that this theory is in any essential manner, unsound.

Einstein and others have achieved notable triumphs in the field of relativity, but no theory of science can for long endure, if even a single pertinent fact proves to be partially irreconcilable with the theory as a whole.

Therefore further work is obviously necessary to finally remove any contradiction or uncertainty from this fundamentally important theory. This further work may lie in one of two (or possibly in both) fields.

1. Experiment.
2. Revised system of higher mathematics.

It has been said that the adoption of a system of physics based on Einstein's foundations will remove the difficulty still thought to exist over Michelson's and Morley's work. Personally, I do not see that this fact in itself will be a guarantee of the accuracy of any theory new or old, especially when it is remembered that the new theory was devised expressly for the purpose.

No, only by recourse to the crucial test of experiment, will the theory be proved immutable.

When Einstein first startled the scientific world with his then revolutionary ideas, many were the difficulties he presented, difficulties incapable of being overthrown simply by a play of ingenious hypotheses or a battle royal with higher mathematics as weapons of attack. Oh,

no! It was necessary to re-adjust our fundamental ideas on space and time.

Many people, even now, are up in arms at the very idea that we should seriously propose to abandon the foundations of the whole structure of physics in order to remove what is only a defect in one (as they say) satellite part—only just connected. They shudder to think that any such importance as we give it should attach itself to just a single difficulty in optical theory.

Such an attitude on their part shows a distinct misconception of the matter as it really stands. Light can no longer be divorced from the general body of physics. The discovery of the electromagnetic nature of things has made optics but a chapter in the theory of electricity. If we have any difficulty concerning the general concept of light then we have a difficulty about radiation.

Are we to argue concerning what some say is a minor matter, and neglect to involve ourselves in a discussion about something, the whole gamut of which is so tremendous that it includes and assumes cosmic significance—in fact the whole phenomena of the universe.

Therefore, let us consider Einstein's two postulates again.

1. It is impossible to detect uniform motion through the ether.
2. In all forms of wave motion the velocity of propagation of the wave is independent of the velocity of its source.

Concerning the first postulate, it is perfectly clear that we can make no direct determination, owing to the impossibility of marking a point in the ether from which to judge the transit of a moving object, from one given point to another. We have seen that the indirect determinations made by Michelson and later workers have uniformly failed to give any positive information.

Turning to postulate No. 2, we know that in all tangible media that this is true in respect to waves, therefore it also suggests itself as equally true in respect to waves in the ether.

The new physics, admittedly has upset the rigid theorists, but to my mind, Sir William Herschel had far more to perturb his mind, when, looking out through his new telescope, he first looked upon the Milky Way, and became aware of the paucity of stars. No wonder he exclaimed "*Mein Gott, da ist ein Loch im Himmel*" (My God, there is a hole in the sky.) In those apparently empty spaces he really believed he was gazing out through our Universe, into vacant recesses of space, millions of miles beyond the stars.

Some years ago, Barnard, at the Yerkes Observatory, when making his photographs of the Milky Way, discovered a great number of what he at first, too, supposed to be empty regions. The more he studied the photographs, the more firmly convinced was he that these dark regions were not vacant patches, devoid of stars, but dark regions of obscuring matter obliterating completely the light of luminous stars beyond. Barnard had to fight as hard as Einstein to ensure acceptance of his views. It was the problem of relativity all over again, not a question of relativity of motion, however, but of relativity of background.

This view, expressed by Barnard was considered rank heresy and even his least militant critics regarded it with scepticism. Yet to-day, the existence of obscuring masses in the Milky Way is doubted by very few competent to express opinion.

So it is now becoming with relativity. Einstein has been honoured by countless Universities and Institutions. One week we find him in Germany, another in England, yet a few weeks hence in America—always preaching his gospel—adding—adding—and adding to his early theories.

A little later we will examine some homely examples of the problem of relativity. Professor A. H. R. Buller, F.R.S., once waxed poetical over the question and the result was:—

"There was a young lady named Bright
Whose speech was much faster than light;
She set out one day
In a relative way
And returned home the previous night."

Such a position of affairs of course is, *untenable, but the verse serves to illustrate* the difficulties presented by studying the problem. I rather imagine that the fourth dimension is better grasped by the philosopher than by the mathematician, except the *mathematician who has given study to non-*Euclidean geometry, as developed by Riemann and Minkowski, the latter being one of Einstein's early teachers at Zurich. At the moment, it appears that we must regard the velocity of light as the limiting, but unattainable velocity of things material. It is possible to conceive greater velocities but only under the condition that they do not involve transfer of matter or energy. In physics, in the measurement of time, mass velocity, and length, the transmission of signals are involved, therefore, the importance of light in relativity is primarily due to fact of it having the greatest measurable velocity with which we are, at present acquainted. Consequently, its velocity in space is constant under all conditions and is universally used for signalling.

Should there be discovered any new finite velocity, surpassing even the great velocity of light its use would undoubtedly lead to the discovery of "third order" effects of such minute smallness as to affect our knowledge of the constitution of nature to a profound degree. The new relativity world is now referred to as a "four-dimensional space-time continuum," three of its dimensions being composed of space and the fourth of time. Events are continuous from point to point in space and from moment to moment in time.

Now, supposing I arrange to meet Brown in a certain office on the third floor of a building on the corner of two intersecting streets, two of the spatial co-ordinates of the office being the streets extending north-south and east-west the third being the floor of the building in which I am to meet Brown. To be at that given point in space does not mean that I shall meet Brown unless the time of the appointment is very clearly specified. Therefore, time becomes equally as important as space; so why should it not be regarded as a fourth dimension? At first blush space seems to differ from time in one particular aspect. I can repeat the spatial part of my meeting with Brown, but never the temporal. Never can I recall five o'clock this afternoon. It is startlingly obvious, however, that I can only relatively repeat the spatial portion of the appointment, for since my meeting with Brown, the earth *has steadily rotated, carrying with it in its* rotation, London, the streets and the building, while the planet itself has moved to a far different point in its orbit in space. Brown and I will never again occupy the original point. Even in a world at absolute rest we could only repeat the event in space —never in time. At all infinite series of states between the two extremes, an event can only be imitated, never repeated.

One new outlook may be consonant with natural laws, but it exhibits a singular lack of harmony with our accustomed modes of thought.

Let us take another case. A passenger in a moving railway carriage throws an orange vertically upwards. He would say that the orange, upon leaving his hand goes vertically upwards—that is straight up. His friend, Robinson, who is watching him perform this feat, standing by the side of the railway track, would undoubtedly assert that the course of the orange is inclined forward. As the things surrounding the experiment in no way influence the course pursued by the orange, let us remove them, the train, the track, the surrounding country, etc.—so that we have just the orange, pursuing its course—which view is to be preferred?

Again let us look upon another experiment.

Let Anson, whom we will call A, measure off from his present position O, two equal lengths OX and OY at right angles to each other. Let A put mirrors at X and at Y. Let him then send a beam of light from O along the path of these two lengths. The light will be returned by the mirrors and thus two flashes will arrive back at O simultaneously. Now let Brown, whom we will call B, in uniform motion in the direction of the line OX, watch these experiments. It will appear to B that it is A who is in motion, and that A, with his mirrors and everything connected with the experiment, is travelling steadily in the direction of length XO. This results in B conjecturing

that the actual course of the light going from O to Y is made up of two sides of a triangle and is longer than twice OY. Hence, if both A and B determine the time taken by the light and then calculate its velocity, it will appear that A's time is lesser than B's. But, to all observers the velocity of light is constant. There is only one way out—A's timing apparatus must go more slowly than B's.

B, therefore draws the conclusion that A's measuring rod must be variable in length and becomes shorter when turned from the direction OY with that of OX. Here then comes the problem of the "space time continuum." B really believes that A's clock has become slow and that his apparatus has shrunk in the direction of motion, but the real answer is that A and B each lives in a world of his own and in these two worlds, space and time are different. Both A and B however are in complete accord as to the speed of light, but each attributes the other's result to an accident—that the deformation from which his world suffers is of such an order as to allow or rather cause the two errors in his calculation to cancel out.

Neither A nor B would be right in preferring the conditions of the one world over the other, by saying that one is right and the other wrong. Space and time are not absolute and immutable. Science being measurable, it behoves us when discussing with A or B, their results, to ask whose space and time is being quoted, because both space and time are foundations of measurement.

In the case of all worlds whose motion with respect to one another is uniform hoth in motion and speed, it may be said that every physical law which holds good in one of them must hold good in all. Consequently our homely experiment with the orange in the railway carriage could be the first of a series of experiments. We could fit up a laboratory in the carriage and all results would be normal—nothing would indicate the train's motion, provided always the train moved forward at a uniform speed and with perfect smoothness.

This restriction of uniform motion is inherent in what Einstein called his Special or Restricted Theory of Relativity, but this restriction is removed in what he calls his General Theory. The endeavours to remove this difficulty were carried out over a period of ten years—so difficult was the undertaking. The Special Theory was announced in 1905 and the General Theory was not completed until 1915, and then because of the Great War was unable to attract universal attention until 1919.

This General Theory may be said to be the fairest jewel in Einstein's crown, but because of the general nature of this paper only a few passing remarks may be made concerning it. Including as it does a complete account of gravitation (a subject hitherto an impenetrable mystery of mysteries even the very beginnings of an attempt at explanation being absent), it is the key to a wider knowledge of the Universe.

The theory provides means whereby the truths of its postulates can be tested by experiment.

Einstein, probably aware of the scepticism of this world, chose an admirably practical test to support his hypothesis. It had long been known that a discrepancy existed between the actual orbit of Mercury and the calculation arrived at by Newton's Laws. The simple path followed by Mercury around the sun, in the absence of any disturbing force, is continually changing owing to the attractions of the other planets. The rotatory alteration of this path is 547 seconds of an angle per century, but by calculation a figure of only 532 seconds is found. Now dynamical astronomy had long been in difficulties over this contradiction, and when Einstein's theory gave a calculated value differing by only one second from the observed value, then great indeed was the support forthcoming.

Yet again, photographs of the eclipse in 1919, taken off the West Coast of Africa afforded further support to his gravitational theory.

An expedition was organised to test a result arising out of the theory of relativity concerning the deflection of a ray of light owing to the sun's gravitational pull. This results in an apparent dis-

placement of the position of stars in close proximity to the Sun. Such stars under normal conditions, are obscured by the brilliance of the Sun, but during the short period of totality in eclipse, photographs revealing their presence can be taken and with success. The photographs taken by the observers of the expedition showed the expected displacement. Although the experiment did not satisfy the theoretical result completely, I feel sure that our twentieth-century Newton will ere long, find yet another means to check this and other results.

(*To be continued.*)

SUMMARY OF THE WORK OF DRS. BOWDEN AND SNOW

ON THE BEHAVIOUR OF VITAMINS AND PRE-VITAMINS IN RELATION TO LIGHT.

Recent work (reported in *Nature,* May 14), by Dr. Bowden and Dr. Snow at Cambridge has shewn that a vitamin is just as easily converted into some other substance by light as was the "pre-vitamin" into vitamin; but that this conversion is effected by radiations of wave-length different from those which produce the latter change. This obviously leads to an improvement in the technique of the production of vitamins artificially; as by arranging the exclusion of the radiations which destroy the vitamin and free passage for those which create it, much richer yields should be obtained.

The experimental work was carried out by exposing the vitamin or pre-vitamin to intense light concentrated thereon by means of massive quartz lenses and prisms in a special apparatus. The action of radiations of various wave-lengths was thus studied. Since the action of light on a substance depends in the first instance on its absorption by that substance, a study of the absorption spectra left it a simple matter to discover which sets of wave-lengths were active, and in which direction.

Carotene possesses some of the properties of Vitamin-A, into which it appears to be converted to some degree in the animal body. Having a red colour, it absorbs visible light, but it was found that these wave-lengths had, as is most usual, but little effect in bringing changes about. The rays which were found to be effective were those of shorter wave-length, that is, the Ultra-Violet part of the spectrum. When a solution of carotene was treated with the appropriate rays, the absorption spectrum of carotene gave place to that of Vitamin-A, and chemical tests confirmed this result. At the time of writing, the animal-feeding tests have some weeks to run.

The pre-vitamin of Vitamin-B has not yet been isolated, but the destruction of the vitamin by the appropriate rays was easily demonstrated by tests on rats. When a rat deprived of this vitamin is spun by the tail, it suffers from a peculiar giddiness, which is immediately cured by a very minute dose of the vitamin, hence the test is very quickly made.

The anti-scorbutic Vitamin-C has been thought by some to derive from narcotin, present in small traces in apples, etc.; on the other hand, small doses of hexuronic acid, obtained from lemons, are definitely effective against scurvy, and this may possibly be the vitamin itself. Work on these substances on the lines suggested above may be expected to clear up the position.

The anti-rachitic Vitamin-D (calciferol) has been obtained from ergosterol by Ultra-Violet irradiation, and the methods of Drs. Bowden and Snow lend themselves to an improvement in the production of this substance.

It is not perhaps possible yet to apply precise physico-chemical methods to the study of the vitamins to such an extent as to eliminate the necessity for tests with animals in detecting and determining these somewhat fugitive substances, vitally necessary to correct metabolism and perfect life and growth; but the work under consideration, besides tending in that direction, undoubtedly offers a striking possibility of the careful control of their artificial production—which seems to be a necessary concomittant of our "advanced" state of civilization. Interesting developments are likely in the near future.

A. H. B.

General News.

CASTOR SEED PRODUCTION IN INDIA INCREASED.

An official estimate of the castor seed crop in India places the present area at 1,563,000 acres, as against 1,462,000 last year, while the estimated yield for 1931-32 is 143,000 long tons, as compared with 120,000 tons in 1930-31, an increase of 7 per cent. in area and 19 per cent. in yield over the 1930-31 crop. The largest increase in acreage and estimated yield was shown by Hyderabad, the area being 792,000 acres in 1930-31 and 856,000 acres in 1931-32; production, 45,000 tons and 63,000 tons, respectively.

ITALIAN PLASTICS AND RUBBER YEAR-BOOK ISSUED.

The first edition of the Italian Plastics and Year-Book has just been issued by Casa Editrice Pollini, Milano (107), at a price of 20 lire. It lists the principal suppliers of plastics material, machinery, manufacturers of molded products, makers of celluloid and artificial horn articles, users of molded articles, suppliers of materials for the rubber industry, a list of rubber manufacturers, and suppliers of rubber machinery and suppliers and users of ebonite. The book is cloth-bound and contains some 200 pages and many advertisements.

DR. LANGMUIR PRIZE AWARD.

Dr. Oscar K. Rice, graduate of the University of California with the class of 1924, has been awarded the $1,000 prize of the American Chemical Society for "outstanding research in the field of pure chemistry," according to a recent announcement from the Berkeley institution. The award, founded last year by Dr. A. C. Langmuir, of Hastings-on-Hudson, N. Y., is the second to be made. The first went to Dr. Linus C. Pauling, of the California Institute of Technology, and visiting lecturer at the University of California.

LISSAMINE VIOLET 5BS A NEW I. C. I. COLOUR.

Imperial Chemical Industries, Ltd., has just added to its line of acid dyestuffs. Lissamine Violet 5BS. It is particularly suitable, in combination with other acid dyestuffs, for the production of navy blue and other mode shades where fastness to light is not of importance. It possesses very good level-dyeing properties and does not stain cotton or artificial silk effect threads, which makes it of special value for the dyeing of piece goods. Lissamine Violet 5BS is of moderate fastness to light, acids and alkalies, but possesses more than average fastness to washing.

THE ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS.

The Association of British Chemical Manufacturers has decided to send its Chairman of Council, Dr. E. F. Armstrong, D.Sc., Ph.D., LL.D., F.R.S., J.P., and its General Manager, Mr. J. Davidson Pratt, O.B.E., M.A., B.Sc., F.I.C., M.I.Chem.E., as its representatives at the Imperial Conference at Ottawa.

YUGOSLAV CONSUMPTION OF BUTYL ACETATE.

The consumption of butyl acetate in Yugoslavia amounts to about 10,000 kilos annually. Three factories manufacture butyl acetate from imported butyl alcohol and, it is believed, supply a considerable share of the demand from domestic lacquer manufacturers. No import figures are available at present to show incoming shipments of butyl alcohol and butyl acetate.

CHEMICAL WARFARE.

On May 10th at Geneva, the General Committee of The International Disarmament Conference decided to appoint, on the recommendation of the bureau of the Conference, a special Committee to consider chemical and bacteriological weapons. All meetings will be held in public.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

York Meeting, August 31—September 7, 1932.

The British Association, under the Presidency of Sir Alfred Ewing, F.R.S. meets this year at its birthplace, so appropriate after a century of service to science and humanity.

When David Brewster in 1831 made the first concrete proposal for the foundation of a "British Association of Men of Science," he addressed it to John Phillips, the Secretary of the Yorkshire Philosophical Society, on the grounds that York was centrally situated for a general meeting such as was contemplated, and that the Society already established there was flourishing and well-managed.

But enthusiasm for science in Yorkshire was, even in those days, by no means confined to its capital, for when the committee of management went to work to circularise all the scientific institutions known to them concerning the proposed meeting, they discovered thirteen in London and twenty-six in the rest of the country, of which nine were in Yorkshire—a laudable proportion. In the premises of the Yorkshire Philosophical Society, then, the British Association was brought to birth on the 26th of September, 1831, and continued its meetings on following days. More than that, it annexed the existing officers of the Society as its own.

Though, not unnaturally, the subjects of papers read at that first meeting depended largely upon the chance of individual men of science, attending the meeting, coming prepared with something to say, yet the classification of papers is not without interest. Six of the communications were on geology and mineralogy, five on magnetism and electricity, four on optics, three on light and lighting, while three were physiological, two meteorological, two chemical and one astronomical.

Since then York has welcomed three further meetings, in 1844, 1881 and 1906, and now the Association returns to the city of its birth for the first meeting after the celebration of a century of existence. For, as Sir Roderick Murchison said at the close of the meeting in 1831. "To this city, as the cradle of the Association, we shall ever look back with gratitude; and, whether we meet hereafter on the banks of the Isis, the Cam, or the Forth, to this spot we shall still fondly revert, and hail with delight the period at which, in our periodical revolutions, we shall return to this the point of our first attraction."

INAUGURAL GENERAL MEETING.

The Inaugural General Meeting will take place at 8.30 p.m., on Wednesday evening, August 31, when Sir J. ALFRED EWING, K.C.B., LL.D., D.Sc., F.R.S., will deliver an Address on *An Engineer's Outlook.*

EVENING DISCOURSES AND LECTURES

Evening Discourses to the Members will be given in the Exhibition Hall at 8 p.m. on Friday, September 2, and Tuesday, September 6. The first Discourse will be by SIR ARTHUR W. HILL, K.C.M.G., F.R.S., on *Plant Products of the Empire in Relation to Human Needs.* The second Discourse will be by Mr. C. C. PATERSON, O.B.E., on *Uses of the Photo-Electric Cell.*

Admission to Evening Discourses will be by membership ticket only.

A Public Lecture (not for members exclusively) will be given by Mr. H. E. WIMPERIS, C.B.E., in the Exhibition Hall at 5.30 p.m. on Monday, September 5, on *High Speed Flying.*

Other Public Lectures will also be arranged.

Section B (Chemistry).

Presidential Address by Dr. W. H. MILLS, F.R.S., on Some *Aspects of Stereo-Chemistry.*

Discussions, etc., on *Stereo-Chemistry, Water Pollution* (with special reference to the present Tees investigations), *Polysaccharides, The Properties of Mixtures.*

It is hoped that support will be forthcoming for the meeting, as such is necessary in order that the Association may continue the obligations it has undertaken. The preliminary prospectus of the meeting and details of membership may be obtained from the Secretary:—

O. J. R. HOWARTH, O.B.E., M.A.,
Burlington House,
Piccadilly, W.

THE PHYSICAL SOCIETY.

May 20, 1932.

The following papers were read.

The fall of potential in a charged insulated cable. By D. K. McCLEERY, B.Sc., A.M.I.E.E.

The expansion theorem of Heaviside is applied to the solution of the problem in which a cable, having been charged until

it reaches its steady state, is insulated at the sending-end, and the potential is required at any point and at any time after insulation. It is found that at the sending-end there is an initial steep fall of potential which is due to a part of the charge being drained away from this end, in order to equalize the potential throughout the line when the exciting source has been removed. After the potential has become uniformly distributed, it falls with time according to a simple exponential law.

On the representation and calculation of the results of gravity surveys with torsion balances. By A. O. RANKINE, O.B.E., D.Sc., F.Inst.P., Professor of Physics in the Imperial College of Science and Technology.

This paper deals with an alternative and, it is believed, superior method of indicating the functions of the Eötvös torsion balance, and of calculating those quantities, depending upon the distortion of the earth's gravitational field, which the balance measures. Remarks are also made on the representation of these quantities—the so-called *gravity-gradient* and *horizontal directive tendency*—and a convenient method is indicated of applying graphically the necessary corrections for the effects of earth's rotation and irregularity of the surface of the ground.

Some observations with a gravity-gradiometer. By O. RANKINE, O.B.E., D.Sc., F.Inst.P., Professor of Physics in the Imperial College of Science and Technology.

This paper gives an account of a series of observations with a Shaw and Lancaster-Jones gravity-gradiometer, during which it was discovered that very persistent, although small, electric charges could be developed on the mica ring forming part of the oscillation-damping system. The origin of these charges has not been ascertained precisely, but one of them has been located and measured approximately by suitable manipulation of the instrument. It is shown that such charges, which may persist for weeks, may not arouse suspicion, although in fact they lead to spurious results in the normal use of the instrument. Thus the apparent gravity-gradient determined by an instrument insidiously charged may have errors of magnitude much larger than the true gradient, and errors of direction of many degrees. It is shown that the effect can be effectively eliminated by introducing into the instrument a sufficient quantity of a suitable ionizing agent, such as mesothorium. This precaution, which can be adopted readily in both old and new gradiometers, is proved to result in a notable improvement in the accuracy and reliability of the instrument.

The propagation along the earth of radio waves on a wave-length of 1.6 metres. By R. L. SMITH-ROSE, D.Sc., Ph.D., A.M.I.E.E., and J. S. MCPETRIE.

A previous paper described an investigation of the attenuation of ultra-short radio waves when transmitted directly along the earth's surface. The present paper reports the progress made in the continuation of this research, the particular wave-length to which attention has recently been given being 1.6 metres. A brief description is given of the simple, but efficient, transmitting and receiving apparatus which has been employed for the experiments on this wave-length.

Measurements of the field-intensity at different distances from the transmitter have been carried out for various heights of the apparatus above the ground level. When both transmitter and receiver are used very close to the ground, the attenuation curve obtained is similar to that encountered at longer wave-lengths. When, however, the apparatus is elevated by an amount comparable with, or greater than, the wave-length, the field-intensity distance curves have maximum and minimum values, the positions of which depend upon the actual heights employed. These maxima and minima are due to interference between waves transmitted directly from the transmitter to the receiver and those which arrive at the receiver after reflection from the earth's surface.

Theoretical curves having the same characteristics have been calculated from a consideration of the reflection coefficient of the earth's surface, account being taken of the electrical properties of the earth. By a comparison of such theoretical

curves with the experimental results, the effective conductivity of the earth appears to be about 95×10^8 e.s.u. (resistivity 95 ohm-cm.) at the very high frequency of 190 megacycles per second employed. This is higher than the values of 5×10^8 to 30×10^8 e.s.u. previously obtained at frequencies of 30 to 60 megacycles per second, and these in turn were higher than the values obtained in earlier work at a frequency of 1 megacycle per second. Owing to this considerable increase in the value of the conductivity as the frequency is raised, the experimental method does not enable the dielectric constant of the earth to be ascertained with any great accuracy, although a value of 10 gives suitable agreement between the theoretical and experimental results in the present case. At the same time this consideration indicates that, from the point of view of practical communications, the value of the dielectric constant of the earth is not a controlling factor in determining the propagation of waves over the earth's surface on either long or short wave-lengths, except in situations where the conductivity of the ground is abnormally low.

Notes on surface tension measurement. By ALLAN FERGUSON, M.A., D.Sc., F.Inst.P., and S. J. KENNEDY, B.Sc.

The first part of this paper deals with a method for the accurate determination of the surface tension of liquids available in volumes of not more than one or two cubic millimetres. The method described does not involve any knowledge of the density of the liquid.

The second part describes a series of measurements of the variation with concentration of the surface tension of aqueous solutions of *p*-toluidine. Here, also, the method employed is independent of a knowledge of the density of the solution.

A demonstration of an experiment on capillary absorption was given by Dr. D. OWEN, B.A.

THE OPTICAL SOCIETY.

May 12, 1932.

The following papers were read :—

The F/1.8 Quartz Monochromator Spectrograph. By J. W. PERRY, of Messrs. Adam Hilger.

The circumstances in which large monochromators and spectrographs of especially high illuminating power are requisite are discussed and the dependence of illuminating power and instrument efficiency upon the essential optical characteristics of such instruments is investigated. A description is given of a large instrument fulfilling the combined functions of monochromator and spectrograph, the relative aperture of which varies from F/1.6 at 0.185 to F/2.0 at 1.2μ, and records of performance are described.

The Transmission of Light in Diffusing Media. By R. F. HANSTOCK, of the Paint Research Station, Teddington.

The transmission of light by thin films of diffusing material is investigated, a flicker photometer being used for this purpose. The intensity I of the diffuse light transmitted by a thin film in the direction which is normal to the surface is related to the film thickness x by the empirical equation.

$$1/I = C(1 + ax + (ax)^2),$$

where a is a constant depending on the opacity of the material of the film to diffuse light and C is approximately constant for all substances. The ability of a film to hide a contrasting background is proportional to the quantity $H = 1/I$, complete hiding being attained for a value of H which is constant for all the materials investigated, namely a variety of white and coloured paints and papers. An accurate method of measuring the opacity or hiding power of such films is described.

THE CHEMICAL SOCIETY OF JAPAN.

Papers communicated :—

NOBUTOSHI ICHIKAWA : Studies on the Volatile Acid of *Libocedrus Macrolepis,* Benth et Hook. Part I.

KINZO KAFUKU and KEIGAI SEBE : On Tectoquinone, the Volatile Principle of the Teak Wood.

NOBUO MORIGUCHI : On the Temperature Regulation of Thermostat.

SINNOSUKE MATUURA : Velocity of Permeation of Electrolytes through a Membrane. VII. Permeation of Weak Acids and Correction to IV (Quantities of Solutions

on Both Sides of a Membrane and the Velocity of Permeation).

SAKUJI KOMAGATA: On the Measurement of Cataphoretic Velocity by the Microscopic Method.

KINZO KAFUKU, TESSAKU IKEDA and CHIUTA HATA: Studies on the Formosan Plants Seed Oils. I.

KINZO KAFUKU, TESSAKU IKEDA and CHIUTA HATA: Studies on the Formosan Plants Seed Oils. II. On the Akagi Seed Oil.

SUSUMU KINUMAKI and SHINROKU MITSUKURI: The Reaction between Ethylene and Chlorine (II). The Reaction between Gaseous Ethylene and Liquid Chlorine (Preliminary Report).

TOZO KUBOTA: On the Nitration of Chlorobenzene. I. The Preparation of 2, 6-Dinitrochlorobenzene, and the Reaction between Nitrophenols and *p*-Toluenesulphochloride.

TOZO KUBOTA: On the Nitration of Chlorobenzene. II. Melting Points of Mixtures of *o*- and *p*-Nitrochlorobenzene, and of 2, 4- and 2, 6-Dinitro chlorobenzene.

SHINICHI AOYAMA and YOSHINAGA OKA: On the Chemical Equilibrium of Metallic Manganese and Water Vapour.

UNIVERSITY NEWS.

Dr. T. J. Nolan, State Chemist, Irish Free State, has been appointed Professor of Chemistry in University College, Dublin, in succession to the late Prof. Hugh Ryan.

Prof. J. C. Philip, O.B.E., F.R.S., has been appointed to the Senate of London University for the period 1932—36.

Manchester University on May 11, conferred the degrees of D.Sc. and LL.D., *honoris causa,* upon Sir James Jeans, F.R.S., and Lord Rutherford, O.M., F.R.S., respectively.

Dr. C. H. Bailey, Professor of Agricultural Bio-chemistry in the University of Minnesota, has been awarded the Thomas Burr Osborne gold medal of the American Association of Cereal Chemists for distinguished contributions to the knowledge of cereal chemistry.

The American Institute of Chemists on May 7, awarded its medal for noteworthy service to the Science and practice of chemistry in America, to Dr. C. H. Herty.

Lord Ebury, D.S.O., M.C., who died in London on May 15, at the age of 48, was at one time employed as a metallurgist by the Canadian Pacific Railway Co., in British Columbia, and later as chief chemist by the Hall Mines, at Nelson, B.C.

Two awards of the Gold Medal of the Institution of Mining and Metallurgy, the highest distinction in its power to confer, have been made by the council: (1) To Sir H. C. Harold Carpenter, F.R.S., in recognition of his eminent services in the advancement of metallurgical science and technology; (2) Dr. T. A. Rickard, in recognition of his services in the general advancement of mining engineering, with special reference to his contributions to technical and historical literature.

Forthcoming Events.

THE PHYSICAL SOCIETY OF LONDON.
THE OPTICAL SOCIETY.

A joint discussion on *Vision* will be held at the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, on FRIDAY, JUNE 3, 1932. First Session, 2.30 p.m. to 5.30 p.m. Second Session, 7.0 p.m. to 9.30 p.m.

Twenty-eight papers by the leading British and Foreign contributors have been promised.

Visitors will be cordially welcomed. No tickets are required.

FRIDAY, MAY 27.

ROYAL INSTITUTE. 21, Albemarle Street, W. 1, at 9 p.m. "New Conceptions of Medical Research," by Sir Walter M. Fletcher, F.R.S.

MONDAY, MAY 30, to FRIDAY, JUNE 3.

INSTITUTION OF ELECTRICAL ENGINEERS. Summer Meeting at the North Midland Centre. MAY 30.—Reunion in the evening at the Grand Hotel, Harrogate. MAY 31.—9.45 a.m., Visit to Leeds. 10.30 a.m. Visit to the Leeds Corporation Power Station and the Central Electricity Board Sub-station at Kirkstall. 8.30 p.m. Reception by the Mayor of Harrogate at the Grand Hotel. JUNE 1.—10 a.m. Visit to the Fryston Colliery of the Airedale Collieries, Ltd. 12.15 for 12.45 p.m. Lunch at Dewsbury Town Hall as the guests of the Yorkshire Electric Power Co. 2.15 p.m. Visit to the Thornhill Power Station. 8 p.m. Dancing at the Grand Hotel, Harrogate. JUNE 2.—9.15 a.m. Visit to Sheffield. 10.45 a.m. Visit to the Neepsend Power Station. Lunch at the Royal Victoria Hotel, Sheffield. 2 p.m. Visit the Works of Messrs. John Brown & Co. 8 p.m. Dancing at the Grand Hotel, Harrogate. JUNE 3.—10 a.m. Visit to York. 2.15 p.m. Visit Messrs. Terry's Chocolate Works. 8 p.m. Dancing, Grand Hotel, Harrogate.

THURSDAY, JUNE 2.

CHEMICAL SOCIETY. *Ordinary Scientific Meeting.* Burlington House, Piccadilly, W. 1, at 8 p.m.

FRIDAY, JUNE 3.

ROYAL INSTITUTION. 21, Albemarle Street, W. 1, at 9 p.m. "Electrical Conductivity of Metals at the Lowest Temperatures," by J. C. M'Lennan, F.R.S.

PHYSICAL SOCIETY. Imperial College of Science, South Kensington, S.W. 7, at 5 p.m.

WEDNESDAY, JUNE 8.

INSTITUTION OF CIVIL ENGINEERS. Great George Street, Westminster, S.W. 1. Conversazione.

THURSDAY, JUNE 9.

OPTICAL SOCIETY. *Ordinary Meeting.* Imperial College of Science and Technology, South Kensington, S.W. 7, at 7.30 p.m.

WEDNESDAY, JUNE 15.

SOCIETY OF GLASS TECHNOLOGY. Sheffield at 2 p.m.

FRIDAY, JUNE 17.

PHYSICAL SOCIETY. Imperial College of Science, South Kensington, S.W. 7, at 5 p.m.

THURSDAY, JUNE 30.

INSTITUTION OF ELECTRICAL ENGINEERS. Natural History Museum, South Kensington, S.W. Annual Conversazione.

New Patents.

These particulars of New Patents of interest to readers have been selected from the Official Journal of Patents and are published by permission of the Controller of H.M. Stationery Office, and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

Group Abridgments can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, either sheet by sheet as issued on payment of a subscription of 5s. per Group Volume or in bound volumes price 2s. each.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, at the uniform price 1s. weekly.

Latest Patent Applications.

12,856.—Buchner, M.—Producing hydroxides and carbonates of alkalies. May 4.

12,636.—Ellis, G. B., & Soc. des Usines Chimiques Rhône-Poulenc.—Manufacture of organic salts of bismuth, etc. May 2.

13,158.—Imperial Chemical Industries, Ltd.—Recovery of sulphur dioxide from gas mixtures. May 6.

12,916.—Reynold, F. D.—Chemical processes. May 5.

12,879.—Rinman, E. L.—Method of producing sodium aluminate solutions. May 4.

Specifications Published.

371,916.—Johnson, J. Y. (I. G. Farbenindustrie Akt.-Ges.).—Manufacture and production of acetylene and carbon black.

371,917.—Johnson, J. Y. (I. G. Farbenindustrie Akt.-Ges.).—Manufacture and production of acetylene and carbon black.

372,143.—Chemische Fabrik Vorm. Sandoz.—Manufacture of antimony compounds.

Abstract Published.

366,417.—Distilling hydrogen peroxide.—Peroxydwerk-Siesel Akt.-Ges., 19, Reichstagsufer, Berlin.

In the production of pure hydrogen peroxide by a fractional distillation *in vacuo*, especially of solutions obtained by decomposing barium peroxide with sulphuric acid, the vapours consisting of hydrogen peroxide and water vapour are freed, prior to condensation, from constituents in the form of mist and drops. This may be effected by passing the vapours through a chamber of such dimensions that the diminution of their rate of travel causes the drops to separate out, by passing the vapours through a layer of finely grained ceramic or other material which does not decompose hydrogen peroxide, or by electrostatic treatment. Specification 167,156 (*Class* 32, Distilling, etc.), is referred to.

The Latest Trade Marks.

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of H.M. Stationery Office, and the Trade Marks Journal can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

MARVO.

530,807.—Chemical substances used in manufactures, photography, or philosophical research, and anti-corrosives. — The Walpamur Company, Limited, Walpamur House, 35-36, Rathbone Place, Oxford Street, London, W. 1. May 11.

DEHAGEN.

530,926.—Chemical substances for mordanting, fixing, dispersing and softening purposes in the dyeing and printing of textile fibres and fabrics.—Durand & Huguenin, Actien Gesellschaft Fabrikstrasse, 40, Basle, Switzerland. May 11.

HYSTABOL.

530,736.—Chemical substances included in Class 1 for use in the treatment of textile fabrics and leather in the course of their manufacture.—H. Th. Bohme Aktiengesellschaft, 29, Moritzstrasse, Chemnitz, Germany. May 11.

TEXAPON.

531,005.—Chemical substances for use in the treatment of fabrics and fibres in the course of manufacture.—Deutsche Hydrierwerke Aktiengesellschaft, Kantstrasse, 163, Berlin-Charlottenberg, Germany. May 11.

THE CHEMICAL NEWS

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Edited by H. W. BLOOD RYAN, M.A., D.Sc., LL.D., Ph.D.
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PRESENT DAY TRENDS IN THE STUDY OF THE STRUCTURE AND NATURE OF THE UNIVERSE

By H. W. BLOOD RYAN, M.A., D.SC., LL.D., PH.D.

President of The Faculty of Sciences, and a Vice-President of the Muslim Association for the Advancement of Science.

(CONTINUED FROM PAGE 346).

Now we come to Tolman's theory of a non-static model Universe with reversible annihilation of matter. He supports his theory by means of a system of thermodynamics which he calls "Relativistic Thermodynamics," in which he treats the type of process which can occur at a finite rate and reversibly without increase of entropy—Entropy here being regarded as a state of run-downness. Professor Richard C. Tolman discussed his new theory before the American Association for the Advancement of Science in the summer of last year, and has contributed several papers in support of or amplification of it in "The Physical Review." In this country Loring commented upon it in October in the "Chemical News," under the formidable title of "Relativistic Thermodynamics."

To say that Tolman threw a bombshell into the field of spacial geometry and physics at that American meeting last summer, would indeed be a mild manner of expression.

For some time past Millikan and Jeans have been carrying on a friendly controversy over the fate of the universe. Tolman's bid for Eternal existence of the universe instead of the present doleful view of stagnation of energy and deterioration seems a reasonable possibility, by the application of his new relativistic thermodynamics to the Universe. Classical thermodynamics has always visualised entropy increasing at such an enormous rate, until the entropy of the universe as a whole would result in the sun and stars cold, with all creation dead and unchanging. Philosophically,

the classical view is hardly acceptable, because the natural question arises. "Why has not the entropy of the universe already reached its maximum value in the infinite past time which has presumably been available?"

So, again philosophically, Tolman's theory should find strong grounds for acceptance.

In dealing with Tolman's theory I have purposely avoided the use of thermodynamical formulæ, but that omission I am sure you will all agree is not one of which you will complain.

The running down of the universe has been much mooted of late, but it seems to run up again thermodynamically at its boundary where the most distant nebulæ are seen to be running away from us; in short, our greater universe is expanding (space is becoming thereby more dilute with matter) and this seems to be demanded by the relativistic thermodynamics just mentioned.

Introducing some newly-published data apropos this far-off phenomenon, the most distant nebulæ—about 100 million light-years from the solar system—appear to be receding from us at the enormous velocity of 12,000 miles per second.

We have in the stars evidence of the annihilation of matter, that is to say, matter turning into radiation, which Jeans has expounded so attractively. This so-called annihilation has been intrepreted as meaning that the entropy of the universe is increasing at a big rate. By introducing a perfect monatomic gas, an ideal gas, in equilibrium with radiation, black-body radiation, as shown by an equation of Stern dealing with the concentration of the hypothetical gas, the conversion of matter into radiation would then take place in the universe under consideration at a finite rate "and yet entirely reversibly without increase of entropy and that this reversible annihilation would necessarily be accomplished also at a finite rate by an expansion of the universe—that is by the kind of behaviour which appears in the actual universe to be associated with a red-shift in the light from the extra-galactic nebulæ."

This is charmingly simple in its bare outline. How Professor Tolman fills in the gaps, that the trained mind in such matters encounters, will be appreciated by studying his original work.

From the older classical thermodynamics the spreading away of radiation as occurring around the sun would involve an increase in entropy, especially as the incoming radiation would be less than that going out, this increase of entropy applying to the local universe. Moreover, the conception of thousands of tons of matter in the sun dissolving into radiation per short unit of time is all in favour of the increasing entropy idea. When, however, the theory of relativity (involving a time factor on all fours with three dimensional space) is brought into play with thermodynamics, then a non-increasing entropy is possible and the evidence of this is apparently manifest in the extra-galactic nebulæ all rushing away from us as to make the universe as a whole an expanding one.

We cannot "see" this relativistic state of affairs immediately around us except through the mode of thought analysis or construction introduced by relativity as applied to thermodynamics; but, we can see its effects most strongly at what appears to be the boundary of our universe where the expanding nebulæ, so to speak, show the effect by the red-shift of their spectral lines. To make this accomplishment more complete and dynamically satisfactory a universal mon-atomic gas has to be postulated.

Some years ago, a student, upon being questioned on points of atomic theory then being taught and accepted as final, replied, with a certain amount of diffidence, "Well Sir, I think the atom is about the usual size and the molecule is the size next larger." Although we now know much more on the subject than we did twenty years ago, the reply is still rather characteristic of popular conceptions—a vague glimmering of the real truth. During the past few years substantial progress has been made in all directions, on the study of atomic nuclei and many new methods of attack have been opened up. The leader in this research field is Lord Rutherford whose work on the subject has

been ably supplemented by his assistants at the Cavendish Laboratory. The recent discussion at the Royal Society on the structure of atomic nuclei throws a brilliant searchlight on the unremitting work of Aston and others, who have been concentrating on the isotopic constitution of the elements, and the relative abundance of the isotopes of many of these elements.

Because of Aston's work, it has become possible to determine the atomic weight of many elements by the use of the mass spectrograph, and with considerable accuracy. The data obtained from this type of work is invaluable, not only from the point of view of radio-active properties, but also as a means of fixing a more accurate time-scale in geology and consequently as an aid to a more accurate determination of the age of our world.

Many years ago, Lord Rutherford focussed the attention of the scientific world on the neutron, and following upon his work, American, English and Continental physicists have flooded the scientific journals of the world with their views and laboratory work thereon. Even I have ventured to write and to say a little on this very thin ice, but fortunately the announcement by Dr. Chadwick, F.R.S., from the Cavendish Laboratory in March last, allows me still to exhibit myself in public, confirming as it did so much that I had expressed on paper, concerning the properties of the neutron.

In the discussion before the Royal Society on April 28 and in which Dr. Chadwick participated, Lord Rutherford said, concerning the neutron,

"The idea of the possible existence of "neutrons," that is, of a close combination of a proton and an electron to form a unit of mass nearly 1 and zero charge is not new. In the Bakerian Lecture before this Society in 1920, I discussed the probable properties of the neutron, while the late Dr. Glasson and J. K. Roberts in the Cavendish Laboratory made experiments to detect the formation of neutrons in a strong electric discharge through hydrogen but without success. If the neutron hypothesis be confirmed by experiment, it will obviously much influence our conception of the formation and constitution of nuclei. Many years ago in a lecture before the Royal Institution, I discussed the possibility of the formation of heavy nuclei from hydrogen through the intermediary of the neutron. It seems not unlikely that the neutrons, owing to their mutual attraction may collect in massive aggregates, which in course of time, by the processes of disintegration and association, re-arrange themselves to form the nuclei of the stable elements. I merely throw out this old idea as one possibly worthy of further consideration in the light of later knowledge."

Following immediately in the order of the discussion Dr. J. Chadwick, F.R.S., said :—

"Experiments in which elements are bombarded by α-particles yield information about the structure of the atomic nuclei in different ways. From the anomalous scattering of the α-particles an estimate of the dimensions of the nucleus and of the height of the potential barrier can be obtained. The disintegration of the nucleus with the emission of a proton gives information about the energy levels of the α-particles and protons of which the nucleus is composed. From some elements γ-radiations are emitted which can be connected with the disintegration. In the cases of beryllium and boron, it seems probable that a new type of disintegration occurs in which a neutral particle of mass 1 is released instead of a proton. The collisions of these "neutrons" with atomic nuclei are being investigated, and in nitrogen disintegrations of the nucleus have been observed. The neutrons thus provide a new tool for the investigation of nuclear structure.

From these statements it appears highly probable that the neutron may become the high-explosive ammunition for the heavy artillery of physics, and thus open up fresh fields for the physicist to explore.

We now come to the recent disintegration of the atom at Cambridge by Dr. J. D. Cockroft and Dr. E. T. S. Walton, working under the director of the Cavendish Laboratory, Lord Rutherford. While for some *time past German and American Physicists* have been working on similar experiments with voltages as high as 10,000,000 volts, the Cambridge men succeeded in their disintegration at only 120,000 volts

I will not bore you with the complete technical announcement of these workers on their method, but, presenting the evidence in non-technical language, from the information available, it appears that disintegration was accomplished by means of a vacuum discharge tube through which millions of particles a second were fired at a speed of 10,000 kilometres a second.

The achievement in this work lies not particularly in the actual disintegration of the atom (that has been done before) but rather in the phenomena manifested during and after bombardment.

In this particular instance energies were procured from the atoms as they broke up 100 times greater than that of the particles by which they were attacked.

As was to be expected and in confirmation of Ramsay's and Rutherford's independent experiments of years ago the positively charged alpha particle expelled from the bombarded atom became a positively charged helium atom.

In April, 1931, Lord Rutherford communicated a paper to the Royal Society describing the use of thyratrons, and in the recent experiment this device was utilised in counting at high speed physical phenomena. The drawback of using a mechanical relay and a counting meter, in conjunction with a valve amplifier, for counting physical events which are repeated very rapidly is that a small but finite time is required by the armatures to move to and fro in the process of counting, and, therefore, if a second particle arrives before the recording of the first has been completed, it will be missed.

The use of thyratron valves removes this difficulty. These valves have negligible inertia and no moving parts, and there is not the small time lag which occurs in any mechanical relay. The use of this device is typical of the progress in physical science.

The thyratron may be regarded as a triode valve which contains a trace of mercury vapour or inert gas at low pressure. Under appropriate conditions, a positive voltage impulse of only a few micro-seconds' duration applied to the grid will cause an arc to strike between the anode and cathode (or filament). The arc then continues independently of further grid potential changes until the anode circuit is momentarily interrupted. In this respect the thyratron behaves as a very delicate, inertialess relay, capable of controlling considerable currents.

Were the alchemists of old such dreamers as we thought? In any case this discovery gives ample food for thought. In connection with all the phenomena displayed during the course of the experiment, Lord Rutherford said that science is on the eve, perhaps, of a great discovery in connection with the structure of matter. Thus speaks one of the greatest, if not the greatest physicist, science has given to the world. Notice his caution, aye his humility even. Now let us look at the wild utterances of several prominent men of science, who should know better, and writers in the popular press. They all acclaim the discovery as something that will instantly revolutionise science, will give to the industrial world the means of harnessing nature to provide as they say "unlimited and practically free power." I have written in a recent paper that man's capacity for scientific discovery has outrun his capacity for understanding the lot of others less fortunately situated than himself. This statement evidently calls for revision and I think I shall amend it to "the intelligence of the mass mind is not equal to the pure reason and clarity of thought necessary to understand the discoveries of science, however simply they are presented."

CONCLUSION.

Many of my correspondents ask me this question: Can Science be reconciled with Religion or rather with the classical idea of God? The probing of science, theoretical and experimental, leads frequently to questions of this nature. It follows naturally, as the night the day, that man's reflection on the structure of matter should react upon his philosophy of life. Man has been millions of years adapting himself biologically and his capacity for thinking during the last few centuries has increased at an extraordinary rapid pace. If we were all content to accept a dogmatic Nicean theology and a pre-Dantean cosmology then such questions

would not arise; but as the majority of people are endowed with intelligence, they use it to ponder over the progress of modern science and wrestle with their knowledge and their religions. The real answer to the question must be the realization that conventional creeds of Religion have not kept pace with the tremendous strides of scientific progress. Reconstruction in scientific thought should, and generally does, entail reconstruction in theological thought. To segregate scientific and religious ideas into watertight compartments shows dishonesty in thinking. No reasonable mind can be at ease with a conflict of thought between two such fundamental outlooks.

The foundation of science is recognition of the principle that the universe is orderly. This orderly existence is recognised by all creeds to be the expression of a Supreme Intelligence and an Ultimate Personality. This belief is expressed in the Christian God, the Hebraic Yahweh, the Moslem Allah, the Polytheism of the Greeks and was first exhibited in the totem worship of primitive man.

Great personalities have risen from time to time in history, Moses, Socrates, Buddha, Jesus and later men of lesser spiritual but greater earthly achievement. An investigation of their missions and effect upon mankind affords more convincing evidence for the existence of an all-powerful Deity than could any laboratory test.

As water does not rise above its own level, neither then does a personality above its source. If one ponders over the marvels of the Universe and all discoveries of science, one cannot contemplate God as a deistic bogey, or as a benign old gentleman, nor as a modern Jove sitting on Olympus puffing out his cheeks when mortals fall, most certainly he can no longer be regarded as a dispenser of favours to members of a selected creed. We no longer dream of teaching astronomy and geology from the first chapter of Genesis, neither do we attempt to distort the beautiful biblical language into an interpretation of Hebraic traditions and a guide to modern science. We take the Bible for what it is, a wonderful collection of the history, poetry, and philosophy of a religious people, but containing little of science. We must take the revelations of science and religion and synthesize them into a single body of thought.

Galileo said, far back in the seventeenth century, that " The Bible was not written to show men how the Heavens go, but to show men how to go to Heaven."

The Creator has endowed man with an intelligence, therefore I infer that he is expected to use it to the best possible advantage, his consciousness is invoked in every region of contact with nature and his inventive genius is rightly expected to exert itself. I do not agree, as suggested by many great thinkers of the past, that a voice ex cathedra once spoke, " Thus far shalt thou go and no further." Man is placed in this world, for but a short while, to play a part. The manner in which he plays that part depends upon two things, his science and his belief.

We must progress in all departments of science. Even to-day, our very exact measurements are at best, approximations and our known laws but rough approximations to the truth of the real secrets of nature.

A general discussion then ensued in which many well known members of the audience participated.

The PRESIDENT then temporarily took the chair and mentioned LORD TAVISTOCK's work in one particular branch of science, namely Economics. How his Lordship had for months' past toured the country, speaking in season and out of season, in a valiant endeavour to show the people how to put their *Economic house* in order, casting aside the dogmatic view, now proved fallacious in so-called orthodox economics, and pointing wherein lay the fault, namely, the lack of " tokens " (money) sufficient in value and quantity to circulate the goods produced and available (and necessary) to the would-be purchaser. Hence our present economic stringency.

Because of this work, the Council of the Faculty had seen fit to confer upon the Marquis of Tavistock, its Honorary Fellowship, a distinction which was retained for those deserving, not by station in life or science alone, but by signal work in one of the sciences. Lord Tavistock in accepting the Fellowship, replied appropriately.

The President then said that the Council of the Faculty, had also decided to confer its Honorary Fellowship upon Professor A. M. Low, whose name needed no introduction to any of his listeners. He noticed, incidently, that Professor Low had hidden himself very near the door, doubtless in order to escape should the lecture have proved too deadening. He was happy to notice, however, that amiable and kindly wizard of physics had still survived, which, at least was some recompense for the preparation, however hasty and so apparently scanty, of the lecture he had just delivered.

Professor Low in accepting the Honorary Fellowship, proposed a vote of thanks to Dr. Blood Ryan and said that, while the lecturer had presented his story in a very charming and facile manner, he had omitted, in telling the recent work of others, to speak of the work which he (Dr. Blood Ryan) had done and was doing for science. He thought that Dr. Blood Ryan had elegantly dressed the conception of the fourth dimension in a manner capable of being understood by all, yet retaining the dignity of science.

Mr. W. H. Wakinshaw, M.A., in seconding the vote of thanks, associated himself with Lord Tavistock's and Professor Low's remarks and stated that the lecturer had proved, in his everyday work and in his foresight in accepting the Presidency of the Faculty, that he at heart, was one of our newer band of scientists, who did not attempt to divorce science from the hard facts of the difficulty of our present-day existence. The manner in which he directed the work of the Faculty, at home and abroad was to be applauded.

Dr. Blood Ryan, in thanking the speakers for their kind remarks specially those remarks apropos the work of the Faculty, said that his performing his poor share in science was a duty and privilege. The work of the Faculty would not have progressed so smoothly and so quickly, had he not the zealous support and willing advice of Dr. Warde Allen, the ever-present honorary secretary. In fact he sometimes wondered where Dr. Warde Allen *existed*, as if he was not to be found at the office of the Faculty, then his all-pervading presence was in and around his (the President's) office or laboratory. With such helpers as these the Faculty would go far and its presence and service would be felt.

THE EXTENDED COLLINSIC OF LIME.

By Hawksworth Collins, B.A.(Camb.).

TABLE LII.

One Form of CaO.

S.G.	**Theor.**		**15°C.**	**3.164**				
S.G.	Obs.			3.161	Karsten.			
				3.18	Filhol.			
						Ca.		O.
O.R.		**14.992**	=	**0.847**		**(13.25**	+	**4.45)**
R.I.		**Theor.**		**1.847**				
R.I.		Obs.		1.83	M.			
O.R.		**14.997**		=		**13.25**	+	**1.747**
H.F.	**(solid)**	**Theor.**		**131083**	=	**59568**	+	**71515**
H.F.	(solid)	Obs.		131500	S.			
H.F.	**(aq.)**	**Theor.**		**145048**	=	**73533**	+	**71515**
H.F.	(aq.?)	Obs.		145000				

The theoretical specific gravity is obtained by dividing 40 + 16 by 13.25 + 4.45.

Whenever an atom of Ca is found to have a relative volume 13.25 in any substance, its optical refractivity is always 13.25, its heat of formation (solid) is always 59568, and its H.F.aq. 73533.

Whenever an atom of oxygen has R.V.4.45 in any substance its O.R. is always 1.757, and its H.F. 71515. But in aqueous solution its H.F. may change to one of the other three forms given in Table LV.

Thomsen admits that he was not satisfied with his own determination of the H.F. (solid) of CaO, and so employed Moisson's value 145000, for *calculating* other results. The present investigation shows that Moisson obtained his result by subtracting 70000, the approximate value for liquid H_2O, from the experimental H.F. of $Ca(OH)_2$ which was about 215000. But this calculation only gave the approximate aqueous value of CaO, which cannot exist as a separate solid entity. Therefore the values given by Thomsen for CaOaq.; $CaOH_2O$; CaO_2H_2aq.; and CaO may be safely ignored.

TABLE LIII.

Another Form of CaO.

S.G.		**Theor.**		**15°C.**		**3.284**		
S.G.		Obs.		Levalloi's		3.32		
				Brugelmann		3.251		
						Ca.		O.
O.R.		**11.866**	=	**0.696**		**(14.54**	+	**2.51)**
R.I.		**Theor.**		**1.696**				
R.I.		Obs.		wanting				
O.R.		**11.866**		=		**10.52**	+	**1.346**
H.F.	**solid**	**Theor.**		**149531**	=	**53376**	+	**96155**
H.F.	solid	Obs.		151900		C.R.P.C.		
H.F.	**aq.**	**Theor.**		**169688**	=	**73533**	+	**96155**
H.F.	aq.	Obs.		170230		C.R.P.C.		

Whenever a Ca-atom has R.V. 14.54 in any substance its O.R. is always 10.52 and its H.F. (solid) 53376. The H.F.aq. is always 73533, whatever the solid form may be.

Whenever an atom of oxygen has R.V. 2.51 its O.R. is always 1.346 and H.F. (solid) 96155.

TABLE LIV.

$Ca(OH)_2$

S.G.		**Theor.**		**15°C.**	**2.072**							
S.G.		Obs.		Filhol.	2.078							
					Ca		O		O		H_2	
O.R.		**21.5677**	=	**0.6038**	**(13.25**	+	**4.45**	+	**0.836**	+	**8.592_2)**	
R.I.		**Theor.**		**1.6038**								
R.I.		Obs.		Wanting.								
O.R.		**21.569**		=	**13.25**	+	**1.747**	+	**1.346**	+	**2.613_2**	
H.F.	**aq.**	**Theor.**	**213808**	=	**73533**	+	**71515**	+	**117460**	−	**24350_2**	
H.F.	aq.	Obs.	215600									

In slaked lime the H_2O is liquid, not crystallised. Liquid H_2O has only appeared once before in the collinsics, viz., in Mirabilite, where its R.V. 15°C. was given as 18.02 which equals $0.836 + 8.592_2$, and its O.R. as 6.572 which equals $1.346 + 2.613_2$.

The H.F. of liq. H_2O, or, in other words the heat of combustion of H_2 at 18°C. is

117460 — 24350_2	=	34380_2	= 68760
Thomsen		34180_2	= 68360
Berthelot		34500_2	= 69000

The figures 117460 and —24350 were frequently demonstrated in the C.N. in the years 1924-1928.

TABLE LV.

Specific Gravity of Calcium.

40	÷	25.66	=	1.56	Theor.
				1.566	Matthiessen.
				1.55	Jobin.

The Law of Heat of Formation.

H.F.		Const.		C.V.		At.Wt.	R.V.		C.V.		O.V.
53376	=	120	×	11.12	×	40	14.54	+	11.12	=	25.66
59568	=	120	×	12.41	×	40	13.25	+	12.41	=	25.66
73533	=	120	×	15.32	×	40	10.34	+	15.32	=	25.66
32341	=	795	×	2.54	×	16	7.53	+	2.54	=	10.07
71515	=	795	×	5.62	×	16	4.45	+	5.62	=	10.07
96155	=	795	×	7.56	×	16	2.51	+	7.56	=	10.07
117460	=	795	×	9.234	×	16	0.836	+	9.234	=	10.07

The third line shows that the R.V. of an atom of Ca in aqueous solution is always 10.34.

TABLE LVI.

Heat of Formation in Aqueous Solution.

					Theor. H.F.	Obs. H.F.
$CaCl_2$	73533	+	63870_2	=	201273	201300 T.
KCl	37274	+	63870	=	101144	101170 T.
$CaBr_2$	73533	+	52930_2	=	179393	179430 T.
KBr	37274	+	52930	=	90204	90230 T.
CaO	73533	+	96155	=	169688	170230
CaO	73533	+	71515	=	145048	145000
CaS	73533	+	36898	=	110431	110230 T.
K_2S	37274_2	+	36898	=	111446	111290 T.
						113500

The results corroborate one another and show without any doubt whatever that the H.F. aq. of Ca is 73533. At the same time they demonstrate the H.F. aq. of other elements.

Summary.

Many other remarks might be considered necessary, but they would only be repetitions from preceding papers.

All available experimental data with regard to Lime have been employed or discussed, and without any hypothesis at all the interdependence of these facts has been demonstrated, and thereby many new discoveries have been made.

The discovery of the structure of an atom of calcium, educed from all substances containing this element, was published in the C.N. 1924, CXXIX 95 and 1931, CXLII,, 257.

The discovery of the four relative volumes of oxygen and of their four corresponding heats of formation, together with the law connecting them (Table V), has made possible the interpretation of thousands of experimental data (published in the C.N. from 1911 to the present time). Previous to this, all these facts were simply isolated figures without definite meaning.

These four in the order in which they are given may be distinguished generally as acidic, alcoholic, neutral and aqueous oxygen

CATALYTIC ZINC:

NEW PROCESS OF BUREAU OF MINES USES NATURAL GAS.

Remarkable improvements in the Maier process for the reduction of zinc ores by the use of natural gas were announced by R. S. Dean, chief engineer, Metallurgical Division, United States Bureau of Mines, at the meeting of the American Zinc Institute in St. Louis, Mo., April 18. These improvements which it is believed furnish the final steps in making this radically new zinc process successful, are the result of a year's further experimentation by the Bureau of Mines at its Reno, Nevada, and Berkeley, Calif., stations, following the announcement of the discovery of the process at the Institute's meeting a year ago.

The Bureau of Mines metallurgists have developed a contact material whose mere presence makes reactions of the new zinc process speed to completion, Mr. Dean states.

The difficulties encountered in large scale experimentation on the process have been overcome by the use of this catalyst which is placed in the retort just before the gases enter the condenser. This catalyst, whose composition has not been fully revealed, causes the complete elimination of oxidizing gases even when the process is operated at higher temperatures and rates than heretofore possible.

The essential features of the process as it has been so far developed by the Bureau, and which it is now hoped will be further developed by industry are: Continuous downward flow of calcine through a metal retort at temperatures of 1,050-1,100° C.; concurrent flow of natural gas to secure intimate contact with calcine; and treatment of gases resulting from reduction with excess methane in the presence of a special catalyst.

The fuel-reagent expense of the natural gas process of zinc reduction represents the equivalent of coal at $1.20 a ton, which is of course a substantial lessening of the important item of fuel costs. Metallic zinc of more than 99.9 per cent. purity at comparatively low costs is a definite probability as the result of the Bureau's work.

Development of the Maier process is the outcome of fundamental studies of metallic oxides begun by the Bureau of Mines some years ago. The success of the experimental work is largely due to the application of precise knowledge of chemical fundamentals, a field in which the Bureau's Berkeley station has specialized. Costs of reagents, thermal economies, maintenance, labour and recovery of by-products, together with the quality of the zinc produced and lower costs of equipment are all favourably influenced by the new process.

INDUSTRIAL WATER PURIFICATION.

Latest Methods of Filtering and Softening.

By a well known Engineer.

A notable advance in the treatment of water for industrial purposes, including the use of closed pressure sand filters for lime and soda ash softening plants and filter presses for the sludge, is represented by the latest plant and equipment of the Paterson Engineering Co. Ltd. of London.

The addition of separate closed pressure sand filters, avoiding the use of self-contained wood wool filters, gives softened water of 4-5° total hardness that is absolutely clear, equal to towns supply, while also complete control of the plant, as well as mixing of the lime and soda ash reagents, can be carried out from the ground level.

For sludge disposal the material is now concentrated into more or less a thick mass at the bottom of the reaction tank, drawn off at intervals, passed through filter presses, and recovered in the form of hard cakes which are easily handled for disposal, quite different from the usual wet and bulky sludge.

In nearly all cases also the settling time allowed in the reaction and precipitation tank is a minimum of 4 hours, a most important point, especially with water containing much magnesium, since the precipitation in this case is in the form of the slowly separating magnesium hydrate.

The firm's standard closed pressure sand filters are of steel plate up to 9 ft. 0 ins. diameter, with dished top and bottom, and

compressed air cleaning, operating at the rate of 120 gallons per square foot per hour. For cleaning the sand is agitated for a short period by means of compressed air or a steam injector, and the disentangled impurities swept away by a momentary reversal of the flow of water, the same sand lasting for years without opening the filters.

A typical industrial installation is a "Paterson" closed pressure sand filtration plant at the works of J. & J. Mc.Callum Ltd., Laighpark Dye Works, Paisley (British Cotton and Wool Dyers Association Ltd. Manchester). The plant consists of four standard 8 ft. 0 in. diameter filters with a total capacity of 20,000 gallons of water per hour. Included also is automatic equipment to add continuously to the water before filtration of a very small amount of alumina, equivalent to about 2 grains per gallon, acting as a coagulent to remove the discoloration characteristic of peaty water. The addition is controlled by a venturi tube device in the delivery main to the filters and therefore varied according to the fluctuations in the demand for water. A steam jet injector is used for agitating the sand before application of a reserve current of cleaning water to sweep away the entangled impurities. Also in this case the source of supply is Paisley towns water taken from an unfiltered storage tank in the works.

As regards water softening a highly important installation of 16 large "Paterson" lime and soda ash water softening plant, having an aggregate capacity of over 6,000,000 gallons per 24 hours, is now being supplied by the firm to the London Midland and Scottish Railway for different stations on the main lines, to treat water for the locomotives. In each case vertical cylindrical mild steel plate reaction and precipitation tanks are being used, varying in height from 20 ft. 0 in. to 60 ft. 0 in., with closed pressure sand filters, complete control and operation of the plant from the ground level, and the use of filter presses for the sludge.

Important also for operation in many industries is the use of lime and soda ash and base exchange plants in series, on the "dual" principle, giving under these conditions a zero hardness water without the disadvantages inherent in base exchange treatment only.

THE BUNSEN SOCIETY MEETING.

Among the number of important papers read at the thirty-seventh General Meeting of the Deutsche Bunsengesellschaft held recently at Munster, that by Lord Rutherford on Atomic Disintegration is of special interest in view of the latest results by his collaborators, Drs. Cockcroft and Walton, at Cambridge. Modern work in this subject has developed, as Lord Rutherford said in his address, from the phenomena of radioactive disintegration whereby alpha-rays are lost as the atoms break up. The investigations upon the disintegration of non-radioactive elements has proved much more difficult, even in the case of hydrogen, the simplest element. Now it has been found possible to break up the atomic nucleus. By bombarding lithium with hydrogen particles it has been possible to split the lithium nucleus into two alpha-particles (helium atoms).

Prof. H. Geiger also delivered a lecture on the significance of the alpha-rays in investigations on atomic structure.

Prof. F. Paneth traced the history and development of our knowledge of isotopes. He began with an account of Soddy's preliminary work in 1913 and the subsequent work of Prof. J. J. Thomson and particularly Aston with the help of his mass spectrograph. The theoretical aspects of the subject were then discussed.

Prof. K. Przibram dealt with the uses of radium rays as means of investigating some physico-chemical properties of solids and Prof. Wolf explained how to prepare highly active precipitates of thorium by new methods.

The neutron was the topic of a paper by Dr. Chadwick, F.R.S., whilst Dr. S. Meyer dwelt upon the recent developments in radio-therapy and Dr. L. Imre described the absorption phenomena observed with certain salts, *e.g.*, barium sulphate, in connection with the preparation of radio-active preparations. Dr. K. Philipp described his experiments upon the natural hydrogen rays and Prof. W. Vernadsky, in a paper discussing radioactivity and the new ideas in geology, showed how profound had been the effect of applying knowledge of radioactivity and its phenomena to the problems of geology.

POLAR LIGHTS.*

By

PROF. SYDNEY CHAPMAN, M.A., D.Sc., F.R.S.

Polar lights, or aurorae, are to be seen most often in the northern and southern polar regions; they rarely or never occur near the equator, though when specially intense they appear in much lower latitudes than usual. They generally extend downwards to about 50 miles height in the atmosphere, and sometimes extend upwards to 400 or even 500 miles height. Their form and colour are often very beautiful; the most usual colour is a pale yellowish green, but violet, grey and vivid red are also seen. In form they are very varied, and they often show rapid motions, and changes from one form to another. Sometimes they appear like great folded and fluted curtains in the sky, sometimes like bows; at other times they resemble crowns, made up of rays and shafts radiating from a point. The rays and flutings are found to be parallel to the direction of a freely poised magnetised needle; this is one of many close connections between the polar lights and the earth's magnetism. As to their cause, much remains mysterious, but it seems likely that the polar lights are due to electrified particles shot out from the sun, which, when coming near the earth, are deflected by the earth's magnetic field towards the polar regions. There they enter our atmosphere, and break up or disturb the atoms or molecules which they meet in their long downward path till their momentum is exhausted. The disturbed atoms and molecules in the air, while spontaneously returning to their normal states, emit the light which we see as the aurora.

* Summary of a lecture delivered before The British Science Guild on May 25th, 1932.

SIR HENRY WELLCOME, F.R.S.

At the last meeting of the Royal Society, Sir Henry S. Wellcome was elected a Fellow of the Society.

Sir Henry Wellcome is founder of the Wellcome Bureau of Scientific Research, a governing director of the Wellcome Foundation, founder of the Wellcome Tropical Research Laboratories at Khartoum, and a generous supporter of medical research. He has conducted archaeological and ethnological explorations in the regions of the Upper Nile and discovered a number of previously unknown ancient Ethiopian archaeological sites.

BEILBY MEMORIAL AWARDS.

From the interest derived from the invested capital of the Sir George Beilby Memorial Fund, at intervals to be determined by the administrators representing the Institute of Chemistry, the Society of Chemical Industry, and the Institute of Metals, awards are made to British investigators in science to mark appreciation of records of distinguished original work, preference being given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy.

Awards are not made on the result of any competition, but in recognition of continuous work of exceptional merit, being evidence of distinct advancement in knowledge and practice.

The administrators of the Fund are the President, the Honorary Treasurers, and the Secretaries of the three participating Institutions, who will meet in the latter part of June, and will be glad to have their attention directed to outstanding work of the nature indicated.

Communications should be addressed to the Convener, Sir George Beilby Memorial Fund, Institute of Chemistry, 30, Russell Square, London, W.C. 1, not later than Tuesday, the 14th June.

LONDON SCHOOL OF HYGIENE & TROPICAL MEDICINE.

(University of London.)

The next series of eight Lectures and Demonstrations on Tropical Hygiene, which are intended for men and women outside the medical profession proceeding to the Tropics, will be given by Lt.-Colonel G. E. F. Stammers, O.B.E., M.R.C.S., L.R.C.P., D.P.H., from 14th to 23rd June, 1932.

These courses of instruction, in addition to providing simple rules for guidance in regard to personal hygiene and preparation for life in the Tropics, will also embrace a short account of some of the more common

diseases, with advice in regard to measures of protection and self-treatment

The synopsis and other particulars can be obtained from the Secretary, London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C. 1.

MOSQUITOES.

23rd May, 1932.

It is not generally realised that Mosquitoes in this country are becoming a serious menace to the comfort and health of the Public.

One of the reasons for the increasing number of these objectionable and irritating insects is the remarkable attitude taken by certain Authorities.

The Epping Forest Committee some years ago invited us to clear a section of the Forest, and when it became known that we proposed to use Medicated Dust, the reception we had from the Local Authorities was distinctly frigid.

It seems to be popularly believed that it is necessary for Mosquitoes to have ponds to breed in, and therefore, many Authorities limit their anti-Mosquito activities to various forms of Paraffin and Phenol Sprays, whereas, as a matter of fact, large tracts of Mosquito breeding areas are not pools at all, and are only capable of being treated effectively by some form of dry dust or powder.

Among the methods of dealing with Mosquito-infested places can be mentioned the treating of stagnant water with Paraffin Spray, draining and levelling marshy ground is helpful, and spreading Medicated Dust containing 1% of Paris Green, are steps in the right direction, while for bites, Iodised Glycerine, Iodine, Ammonia, etc., are all of value.

Boy Scouts, Girl Guides, Ramblers, and Hikers could all render valuable assistance by some form of co-operation with local and Municipal Authorities, and I venture to think that apart from doing real valuable work for the Community, such co-ordinated action would give point to the enjoyment of many outings and outdoor excursions.

A. Moore Hogarth,
Chairman.
The College of Pestology,
233, Pentonville Road, N. 1.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

Thursday, May 26, 1932.

The following papers were read:—

Some Measurements of Upper-Atmospheric Ionisation. By E. V. Appleton, F.R.S., and R. Naismith.

Experimental work on the reflection of wireless waves by the upper atmosphere has shown that if the frequency of waves, protected vertically upwards, is steadily increased, the Kennelly-Heaviside layer (Region E) is ultimately penetrated and reflection takes place at the upper region (Region F). The critical penetration frequency, for which reflection at Region E ceases and reflection at Region F begins, is found to vary diurnally and seasonally. From measurements of the critical penetration frequency made in South-east England the variation in the maximum ionisation content of the Kennelly-Heaviside layer has been studied. The value of this ionisation is found to be at a maximum at noon and at a minimum just before dawn. The diurnal variation curves are found to correspond very closely to the theoretical curves obtained by S. Chapman in his study of the atmospheric ionisation produced by a solar stream of monochromatic radiation. Summer noon ionisation is found to be about 2½ times as intense as winter noon ionisation.

Experiments with High Velocity Positive Ions. I and II. By J. D. Cockcroft and E. T. S. Walton. Communicated by Lord Rutherford, F.R.S.

In order to obtain high steady potentials for the acceleration of protons, a method has been developed by which the voltage of a transformer can be rectified and multiplied several times by an arrangement of valves and condensers. A rectifier system has been built consisting of four glass cylinders placed end to end, and arranged in the form of a tower 12 feet high, the cylinders containing suitable electrodes and hot filaments and being evacuated continuously. With this apparatus and four condensers, a potential of over 700 KV. has been obtained, which is steady to within a few per cent. The

method used is a special case of a more general method of transforming steady potentials from low to high voltages and in the reverse direction.

The voltage of the rectifier is applied to an experimental tube which is built to allow positive ions to be accelerated by the full voltage available. Positive ions of hydrogen are directed down the axis of two glass cylinders and focussed by suitable electrodes, current of the order of 10 microamperes being obtained. Protons having energies up to 710 KV. have been produced and have been transmitted through a mica window into an experimental chamber at atmospheric pressure where their ranges are measured.

GEOLOGICAL SOCIETY OF LONDON.

May 11th, 1932.

PROF. W. W. WATTS, LL.D., Sc.D., M.Sc., F.R.S., Vice-President, in the Chair.

PROF. WILLIAM A. BONE, D.Sc., Ph.D., F.R.S., delivered a lecture on *Some Recent Investigations on the Maturing and Chemical Constitution of Coal.*

The lecturer reviewed recent researches, and more particularly those carried out in his own laboratories upon the chemical constitution of coals and their maturing, including the causes and development of their coking propensities.

The importance of dealing with the problem as fundamentally one of organic chemistry was stressed, and the different lines of 'thermal,' 'solvent,' and 'chemical' attack were explained, together with the experimental methods involved. It was shown that mere ultimate analyses of the 'dry-ashless coal substances' have little significance apart from a knowledge of the inner chemical structure of coal.

It was shown, in the first place, how properly graded experiments upon the thermal decomposition of *dry* brown-coals have revealed the operation of their successive and independent chemical changes; namely, the elimination (i) of CO_2 and H_2O simultaneously as if by some internal 'condensation,' (ii) of methane, higher paraffins, and olefines, as if by the splitting off of alkyl side-chains, etc., and (iii) of hydrogen. The results of typical 'solvent-attacks' (and more particularly of pyridine and benzene, respectively) upon the coal substance were then discussed. The superiority of the *benzene-pressure-extraction* was explained, and its application to brown-coals, lignites, bituminous coals, etc., set forth in detail. The lecturer described how the coking propensities of bituminous coals can be ascribed to the presence or formation therein of certain chemical constituents which, there are strong grounds for believing, have originated in, and gradually developed from, the phenolic constituents of brown-coals. Also, that such 'coking constituents' are substantially absent from semi-bituminous coals and anthracites.

Finally, the chemical constitution of the *main coal-substance* (that is, of the 'residue' after the benzene-pressure-extraction) was discussed in the light of recent discoveries. It was shown that the C/H ratios of *all* such 'residues,' whether from brown-coals, lignites, or bituminous coals, would suggest a 'benzenoid structure,' and how this anticipation has been borne out by the discoveries in question.

Thus, it has been found that such coal 'residues' are completely oxidized by hot alkaline-permanganate solution to carbonic anhydride, acetic and oxalic acid, and a mixture of benzene-carboxylic acids, and that in each particular case a 'carbon-balance,' showing its distribution among the various oxidation products, can be established experimentally; such carbon-balances for typical coals of varying degrees of maturity were shown and discussed. The proportion of the original carbon finally appearing as benzene-carboxylic acids in the oxidation-products varies from about 30 up to 50 per cent. (or more); but, owing to the nature of the oxidation-process, this by no means represents all the 'benzenoid' carbon in the original coal-substance.

The course of the oxidation would seem to be 'stage-wise'; possibly something as follows:—

Coal substance → {colloidal humic acids} {crystalline acids} → {acetic, oxalic, benzenoid acids}

plus carbonic anhydride at varying intermediate points; and, at one time or other, no less than ten out of the twelve possible benzene carboxylic acids have been isolated from among the oxidation products.

These researches have not only afforded the first unimpeachable quantitative evidence of the essential 'benzenoid' constitution of the main coal substance, but also established new experimental methods and technique for the exploration of the new field thereby opened; some of their implications were discussed.

So far as has been ascertained at present no benzenoid acids result when cellulose is similarly oxidized by means of hot alkaline permanganate, and the experiments are being extended to both lignin and peat, the latter of which has already shown some evidence of benzenoid structure. The question naturally arises as to whether coal has been so directly produced from lignocelluloses as has usually been supposed hitherto, or whether it may have to be regarded as a synthetic product built up from the much simpler material into which lignin (with or without celluloses) is resolved during the 'peat-bog stage.'

Prof. Bone illustrated his lecture with lantern-slides and exhibited samples of carbon-balances of typical coals of varying degrees of maturity.

May 25th, 1932.

1. *The Influence of Geological and Climatological Factors on the Distribution of non-marine Fossil Reptiles and Stegocephalia.* By BARON FERENCZ VON NOPCSA, FOREIGN MEMBER. (Communicated by the Foreign Secretary.)

A study of the terrestrial tetrapods and their distribution indicates three lines of migration in Upper Palæozoic and Lower Mesozoic times: (1) North America to Europe, thence through India and the Malay Archipelago to Australia, and from there to South America; (2) Central Asia to South Africa; and (3) Africa to South America.

In Jurassic, Cretaceous, and Tertiary times there appear four lines: (1) Europe to Asia, the Malay Archipelago, and South America; (2) Asia, Fenno-Scandia, Greenland, and North America; (3) Central Asia to South Africa; and (4) North Africa to Brazil. To some extent these migratory lines are the same as those of Upper Palæozoic and Lower Mesozoic times.

An attempt is made to correlate them with large-scale tectonic movements of folding and marine transgression, together with continuous changes in the ecliptic, bringing about a cycle of climatic and seasonal changes.

2. *The Geology of the Country between Abergwesyn (Breconshire) and Llansawel (Carmarthenshire).* By KENNETH ARTHUR DAVIES, M.Sc. Ph.D., F.G.S.

The country described comprises about 130 square miles, and lies on the north-western side of the Towy anticlinorium. The rocks belong wholly to the graptolitic facies, and are very similar to those in adjacent areas which have already been described. They range from the Bala, through the Birkhill to the Gala stage, and consist of shales and mudstones with subordinate grits and conglomerates. In contrast with most parts of Central Wales, arenaceous material is common at many horizons. An inlier of green and purple sediments also falls within the area described.

The base of the Middle Birkhill and the base of the Gala overlap the rocks below, though the latter transgression is to be seen over a greater area than the former.

Evidence of contemporaneous folding transverse to the subsequent Caledonian System is obtained here as in the areas where the shelly facies is developed.

It is suggested that the differences in grain are indicative of the varying depth of the sea-floor when deposition took place, the coarse deposits being laid down in banks tailing off from the areas shallowed by the cross folding movements.

3. *The Conglomerates and Grits of the Bala and Valentian Rocks of the District between Rhayader (Radnorshire) and Llansawel (Carmarthenshire).* By KENNETH ARTHUR DAVIES, M.Sc., Ph.D., F.G.S., and JOHN ISAAC PLATT, M.Sc., F.G.S.

The grits and conglomerates discussed in this paper occur within the rocks between the Lower Gala and the Upper Bala stages

in the region lying on the western side of the Towy anticlinorium, between Rhayader (Radnorshire) and Llansawel (Carmarthenshire). The sediments dealt with occur within shales and mudstones of the graptolitic facies of the groups represented.

A description is given of the distribution and field characteristics of the arenaceous bands, as well as a petrographical description of the included pebbles of the conglomerates and of the heavy mineral constituents of the grits. Most of the pebbles are quartzite and vein-quartz; sandstones, shales, etc., also occur frequently, but numerous pebbles of igneous rocks were found, as well as a few metamorphic types. The majority of the igneous pebbles are acid volcanic rocks, but interesting intrusive types also occur. All the igneous rocks are rich in soda. Suggestions are made regarding the mode of deposition of the coarse deposits, and the possible source or sources of origin of the material is discussed.

Notices of Books.

Colloid Chemistry (Theoretical & Applied) Vol. IV. Collected and edited by JEROME ALEXANDER. (The Chemical Catalog Co. Inc., New York.) Price $11.50. Pp. 734.

Volume IV of this comprehensive work deals with the technological applications of Colloid Chemistry to the whole range of Carbohydrates, to Explosives, Sizing, Dyeing, Rubber, Plastics, Tanning, Photography, Paints, Electrodeposition, Foods, Laundry and Dry Cleaning, "Solidified" Alcohol, Fire Extinguishers, Water Supply, and Sewage Disposal.

A very broad field indeed has thus been covered, and a remarkahle feature of the work is the manner in which the Editor has laid the whole world under contrihution. Among the authors of the individual papers Great Britain, Canada, and Australia are well represented, the United States of America naturally appear in full force, and other countries contributing are Austria, Belgium, China, Czechoslovakia, France, Germany, Holland, Hungary, India, Italy, Japan, Jugoslavia, Mexico, Palestine, Poland, Roumania, Russia, Spain, and Sweden.

An example of the meticulous care and thoroughness with which these authors have attacked their tasks is provided in the first section, dealing with perhaps one of the most difficult of all subjects studied by the Chemist—Cellulose. The references to literature total no fewer than 835, occupving over nine pages.

An enthusiastic treatise on the subject of Beer coming, as might be expected, from Germany, ought to be read by all those who endeavour to wean our people from this ancient and healthy food as well as those whose duty it is to see to the value of the supplies that are still permitted to reach our lips.

The scope of this stupendous work is to say the least ambitious; and it is fair to say that those responsible for it have achieved something very substantial in the way of success. As a book of reference for the Works Chemist engaged with any of the substances mentioned, it should prove invaluable when there arise those difficulties that occasionally baffle the most experienced. If there is not an adequate statement dealing with the problem in hand, it will surely be the case that the notes will lead rapidly to the best authority available for complete reference.

Considering the whole work of four volumes, the Editor and his collaborators deserve our thanks and our congratulations. A. H. B.

Allemeine Chemie der Enzyme, by PROF. J. B. S. HALDANE and Dr. KURT G. STERN, with an introduction by PROF. DR. L. MICHAELIS. Pp. xii + 367. Dresden and Leipzig: Theodor Steinkopff, 1932. Price 22 marks.

It has been so much the fashion to translate German scientific treatises into English that it is quite an event to find Prof. Haldane's Monograph on Enzymes, which appeared in English just two years ago, has been translated into German by Dr. Stern who has, however, taken the opportunity of changing here and there the original text. Prof. Haldane himself, we are told in the Preface, suggested a number of alterations and the translator, who is also a specialist in this field, has added new matter in connection with the "specific" nature of enzymes, co-enzymes, their poisoning and the theories of their behaviour.

The English edition, it will be recalled, dealt with the general characteristics of enzymes, their concentration and purification, a study of the external factors (temperature, etc.) influencing their behaviour. All this has, of course, been retained in the German edition to which Prof. Michaelis has contributed a Foreword. He refers to the importance of Prof. Haldane's work, contributing as it does, so much recent matter and the latest views based upon modern results.

The book appears as Volume 28 of Messrs. Steinkoff's *Wissenschaftliche Forschungsberichte* issued under the editorship of Prof. Liesegang and is assured of a wide circulation among the German-reading scientific public.

The Manufacturing Industries of the British Empire Overseas. Africa: West, East and Central. Published by Erlangers Ltd., 4, Moorgate, London, E.C. 2. Price 7/6.

This is the concluding volume of the series of six monographs embracing the whole field of the British Empire Overseas—with the exception of the Irish Free State, India, and a few outlying countries in the Pacific.

In the Preface (pages 9 and 10) the causes of the world crisis are reviewed, and the importance

of the forthcoming Imperial Conference at Ottawa is stressed. Great Britain and the Empire have been the predominant moral and financial force in the world for the last fifty years, and London, despite its departure from the Gold Standard, is still the world's financial centre. It is held that the prosperity of the world is bound up with the recovery of Britain and that this crisis cannot end until Britain is once more established as the financial arbiter and able to lend with the same freedom as before the War. The difficulties facing the Conference are discussed, and it is considered that if viewed imperially they will be overcome.

A map of Africa showing the "Congo Basin Area" faces page 14, and an analysis is made (pages 11-14) of the treaties now in force which prevent many of the British countries in Africa from granting a preference on manufactured goods from Great Britain.

The present tariffs (May, 1932) of all the British countries in Africa are presented in a condensed form in Diagram No. 33.

Comparative statistics of all countries in Africa, both British and foreign, are shown in Diagram No. 34 and the accompanying Table.

A synopsis of the history and economic position of each British country in Africa, together with the imports and exports for the years 1926-1930 of the principal goods, are shown in Diagrams Nos. 35 to 45.

The copper deposits of Northern Rhodesia are a potential source of supply for the Empire and the world, and on pages 19 and 20 will be found a review of the present world position of the copper mining industry in relation to its future in Northern Rhodesia.

An analysis of the present position of Kenya and Tanganyika, and especially of the sisal industry will be found on pages 22 to 25.

Africa is one of the principal markets for the Lancashire cotton trade, and statistics of the imports of cotton manufactures into the British countries in Africa, with the principal countries of origin, are shown for the year 1930 on pages 26 to 29.

New Patents.

These particulars of New Patents of interest to readers have been selected from the Official Journal of Patents and are published by permission of the Controller of H.M. Stationery Office, and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

Latest Patent Applications.

13,719.—Laporte, Ltd., B., and Weber, I.E.—Production of precipitated titanic oxide. May 12th

13,690.—Roessler & Hasslacher Chemical Co.—Manufacture of hydrocyanic acid. May 12th.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, at the uniform price of 1/- each.

Abstract Published.

Group Abridgements can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, either sheet by sheet as issued on payment of a subscription of 5/- per Group Volume or in bound volumes price 2/- each.

366,183.—Arsinic acids.—Ellis, G. B., 70, Chancery Lane, London.—(Soc. des Usines Chimiques Rhone-Poulenc; 21, Rue Jean-Goujon, Paris).

2-Nitro-5-aminobenzyl alcohol; 4-nitro- and 4-amino-3-oxymethylbenzene-1-arsinic acid.—4-Amino-3-oxymethylbenzene-arsinic acid is prepared by nitrating 1-acetylamino-3-acetoxymethylbenzene at a temperature below — 5° C., saponifying with hydrochloric acid to eliminate the acetyl groups, subjecting the resulting 2-nitro-5-aminobenzyl alcohol to Bart's reaction, and reducing the 4-nitro-3-oxymethylbenzene-1-arsinic thereby obtained. Details are given relating to each step of the process. The 4-amino-3-oxymethylbenzene-1-arsinic acid possesses therapeutic properties. Its sodium, nickel, and cobalt salts are referred to, whilst it is stated that the sodium salt, when treated with a solution of gold chloride in a bicarbonate solutino, gives a red gold colloidal solution. When diazotized and coupled with chromotropic acid in alkali, the arsinic acid gives an intense red solution.

The Latest Trade Marks.

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of H.M. Stationery Office, and the Trade Marks Journal can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

NELSCO.

529,484.—Chemical substances used in manufactures, photography or philosophical research and anti-corrosives.—George Nelson, trading as Nelson Sons & Co., Millwell Lane, Bolton. May 18.

SILHOUWELT.

530,861.—Chemical substances for use as solvents for cements.—The British United Shoe Machinery Company Limited, Union Works, Belgrave Road, Leicester. May 18. (Associated.)

THE CHEMICAL NEWS

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Edited by H. W. BLOOD RYAN, M.A., D.Sc., LL.D., Ph.D.

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EDITORIAL

Nisi utile est quod facias, stulta est gloria, is a sentiment which meets with almost universal acceptance, but in accepting it we must walk warily lest we fall in the narrow paths. The study alone, of science, possesses a cultural value entirely independent of the utility of its application, and with the awakening of greater interest the *Chemical News* seeks to serve that wide and diverse public which is not confined to these shores, but which is spread throughout the educational and industrial centres of the world. Science is claiming a fuller and wider recognition as a means of closer contact with nature and the Infinite.

Many years ago Crookes wrote in this very journal " In its pages some of the most important chemical and physical discoveries have for the first time been published and investigators have frequently made use of its pages to secure priority of a discovery by bare mention of facts and results before publishing their full papers. . . . The Editorial staff of the *Chemical News* comprises gentlemen in the first rank of science . . . . and have made the *Chemical News* the first authority on all matters treated of in its pages. Bound to no clique, connected with no institution and representing no trading firm, the Editor can have no temptation to act or write under any contingency otherwise than in a fearless and independent manner. No trade puffs have ever disgraced its columns, no unworthy book or patent has ever been recommended in its pages; and, based and conducted on these principles, the *Chemical News* has attained its influential position as the representative of scientific progress. The long period of existence (*then only* 8 *years be it noted*) of the *Chemical News,* and the high position which it has always taken, have gradually led to its introduction into all the public and private libraries, laboratories, museums, institutions, etc., on the continent and America . . . . The attention of scientific investigators is earnestly directed to these considerations, for in the majority of cases the only rewards which the man of science can ever secure are fame and the appreciation of his labours by fellow-workers.

" With the exception of the *Philosophical Magazine* (established in 1798) and the official proceedings of the learned societies, no other English scientific journal enjoys this universal diffusion. . . . It has become an indispensable addition to their scientific libraries, and an oft-quoted record of the progress of chemical research. The admission of an original paper into the pages

of the *Chemical News,* therefore, secures its rapid diffusion over the whole world."

Thus spake Crookes, the giant of scientific thought and work whose centenary falls on 17th June, but a few days hence. What was true in the above words is equally true to-day. Other journals have sprung up in the train of the progress of science, some dealing with pure, others with applied, science. All are ably conducted and all fit into a niche peculiar to the requirements they respectively and individually set out to fill. The relations between these newer papers and the *Chemical News* are of the most cordial nature, both at home and abroad. We of the Editorial Staff of this journal are not unmindful of the tradition handed on to us to keep unsoiled—and we attempt, in our humble way, to carry out, what we believe, would still be the policy of the journal's illustrious founder.

The issue of the *Chemical News* bearing date 17th June, will be devoted, as much as possible, to a retrospect of the life and work of Crookes, containing articles by international investigators. The issue will be enlarged in number of pages and will be an attempt, restricted, naturally, by the stringency of the parlous time through which the world is passing, to pay some small (and hopelessly inadequate) token of respect to a past famous scientist and a great humanitarian.

Science, in years to come may view much of Crookes' work lightly (that is inevitable), and his incursions into psychical research may be deplored. That is not for us to judge, only the passage of time and new ideas will be the test. Be all that as it may, no one can or will dispute the countless benefits his work has conferred (indirectly in some cases) upon humanity, and our duty on June 17th will be to praise, as Fournier D'Albe says "a man of the people, English of the English, a searching and painstaking student and investigator of Nature's secrets, an inspired prophet of future progress, a fearless expounder of new truths, a loyal friend, a chivalrous antagonist, a devoted husband, son and father, a sturdy patriot, who yet had room in his great heart for fellow-creatures of all nations."

RECENT RESEARCHES ON THE GAMMA RAYS.

By Lord Rutherford of Nelson, O.M., M.A., D.Sc., LL.D., F.R.S., M.R.I.*

Cavendish Professor of Experimental Physics, University of Cambridge, Professor of Natural Philosophy, Royal Institution.

It has long been known that some of the radio elements emit a penetrating type of X-rays known as the γ-rays. It is clear that these radiations arising from the nucleus of the radio active atom represent in a sense some of the characteristic modes of vibration of the nuclear structure. The wave length and quantum energy of many of the stronger lines in the complicated γ-ray spectrum have been determined by different methods with concordant results. It has been difficult to determine with certainty the origin of this radiation. It was at first supposed that it must arise from the motions of electrons in the nucleus, but in recent years there has been a growing belief that the radiation is connected with the transition of an α-particle or proton which forms part of the nuclear structure. It is not an easy matter to distinguish between the various hypotheses, since very little is known about the detailed structure of the nucleus. Fortunately, during the last two years, two different methods of attack on this problem have been developed. The first depends on an analysis of the groups of long range α-particles which are emitted in small numbers from radium C and thorium C, and the other the analysis of the fine structure shown in the emission of α-rays from certain bodies. It may be supposed that the emission of a β-particle during a transformation causes a violent disturbance in the resulting nucleus, some of the constituent α-particles being raised to a much higher level of energy than the normal. These α-particles are unstable and after a very short interval fall back to the normal level, emitting their surplus energy in the form of a γ-ray of definite frequency. According to the ideas of wave-mechanics, in this short interval there is a small chance that some of the α-particles in the higher levels can escape

* Substance of a Lecture given at Royal Institution, Friday, March 18th, 1932.

from the nucleus. On these views, the escaping α-particles represent the long-range α-particles observed and the energy of the α-particles gives the value of the energy level in the nucleus which it occupied before its escape. Following out these ideas, the long-range α-particles which escape from radium C have been carefully analysed, using the new electrical methods of counting α-particles.

Nine distinct groups of particles were observed, and the energies of α-particles forming each group were determined. The differences of energy between the various groups were found to be closely connected with the energy of some of the most prominent γ-rays in the spectrum, and, in general, the experiments gave strong evidence that the γ-rays had their origin in the transition of one or more α-particles in an excited nucleus.

It has generally been supposed that in a radio-active transformation all the α-particles are expelled with identical speed. This is certainly the case for most bodies, but Rosenblum found that the element thorium C emitted not one but five distinct groups of α-particles. This discovery was made possible by making use of the great Paris electromagnet in order to bend the α-particle into a semicircle. Gamow pointed out that the appearance of such a "fine structure" in the α-ray emission should be accompanied by the liberation of γ-rays.

Owing to certain experimental difficulties, it is not easy to obtain a clear-cut decision on this point. Ellis concludes from his experiments that Gamow's view is correct, but Meitner from similar experiments reached an opposite conclusion. In view of this difference of opinion, I have made, in conjunction with Mr. Bowden, some experiments to throw light on this problem in another way. Recently Lewis and Wynn Williams found that the actinium emanation emitted two distinct groups of α-particles differing in energy by about 340,000 volts. It was seen that this observation offered a simple method of testing the theory of Gamow. The emanation was carried by a current of air into a separate chamber and the emission of β- and γ-rays directly tested. It was found that the transformation of the emanation was accompanied by a weak β-radiation, and a strong γ-radiation. The experimental results were in good accord with the theory, and thus showed that the presence of a "fine structure" in the α-ray emission is accompanied by the emission of γ-rays. At the same time, the results offered strong corroborative evidence that the γ-rays have their origin in the transitions of an α-particle in an excited nucleus.

It is of interest to consider how far these views can be carried into the region of the artificial disintegration of the elements resulting from the bombardment of certain light elements by α-particles. In some of these disintegrations it is necessary to assume that the α-particle can be captured in different energy levels, and that a γ-radiation is emitted as a result of the transition between the two levels. Penetrating radiations have, in fact, been observed in several cases when light elements are bombarded by α-particles. Some of these cases are of particular interest.

The Radiation from Beryllium and the Neutron.

In examining the artificial disintegration of light elements under the action of α-rays, Bothe and Becker in 1930 noted that beryllium under α-ray bombardment did not emit protons like boron or nitrogen, but gave out a weak radiation which was more penetrating in character than the γ-rays from radium. The absorption of this radiation in its passage through matter was later examined in detail by Mme. Corie-Joliot and M. Joliot and by Webster.

It is usual in experiments of this kind to employ active preparations of polonium on a metal disc as a source of a α-rays. This source is very convenient for the purpose, as the results are not obscured by the presence of β- and γ-rays, which are so freely emitted from other α-ray sources such as radium C and thorium C.

In examining the absorption of this beryllium radiation by the ionisation method, Mme. Curie-Joliot and M. Joliot made the striking observation that hydrogen material, when exposed to this radiation, emitted

swift protons. They suggested that if the protons gained their energy by a radiation recoil in a process similar to the well-known Compton effect, the quantum energy of the radiation must be of the order of 50 million electron volts.

J. Chadwick, using direct counting methods of great sensitiveness, found swift recoil atoms were liberated not only in the passage of the radiation through hydrogen, but also in other light elements, including helium, lithium, beryllium, carbon, air and argon. In a recent letter to *Nature** he pointed out that the results in this and other directions were difficult to reconcile with the hypothesis of a quantum of radiant energy of such high frequency. He suggested that the effects observed were not due to a γ-radiation at all, but to the liberation from the bombarded beryllium of a stream of swift uncharged particles or "neutrons."

The idea of the possible existence of neutrons, that is, of a very close combination of a proton and electron to form an uncharged nuclear unit of mass nearly 1, is not new to science, but it has been very difficult to find any definite evidence of its existence. Rutherford discussed the properties of such a neutron in the Bakerian Lecture before the Royal Society in 1920, and both the late Dr. Glasson and Dr. Roberts made experiments in the Cavendish Laboratory to test whether neutrons were produced in strong electric discharge through hydrogen, but without success.

It is to be anticipated that a projected neutron would produce very little ionisation in its passage through matter, and would pass freely through the outer structure of atoms. A swift neutron should, however, indicate its presence by the recoil of an atomic nucleus with which it collided. This recoiling nucleus with which it collided. This recoiling nucleus would spend its energy of motion in ionising the gas, and should thus be readily detected by its electrical effect, or by the trail of water drops it produces in a Wilson expansion chamber. In some respects, however, the effects produced by a neutron would be very similar to those due to a quantum of high frequency radiation, and careful experiment is required to distinguish between them,

A discussion was given on the present state of the experimental evidence on this important problem. The velocity of the neutron at the moment of its liberation is estimated to be about 3×10^9 cm./sec., or about one-tenth of the velocity of light. By comparison of the velocity of recoil of different atoms, Chadwick finds that the mass of the neutron is about the same as that of the hydrogen atom. In addition, the velocity of recoil of a given atom falls off when the radiation is passed through increasing thicknesses of an absorbing material like lead. This is exactly the behaviour to be expected for the neutron, but not for a high frequency radiation.

Very valuable information on this problem can be obtained by photographing the effects due to the passage of this new type of radiation through a Wilson expansion chamber. A number of such experiments have been made by N. Feather and P. I. Dee in the Cavendish Laboratory in association with Dr. Chadwick. For example, it is to be anticipated that the neutron would occasionally collide with the electrons in its path, and thus give rise to an electron track of maximum length corresponding to twice the velocity of the neutron. This is exactly analogous to the well-known production of δ-particles by the passage of α-particles through gases. Several such short electron tracks have been photographed by Dee which have about the right length, and for which it is difficult to suggest any other explanation. Feather has obtained photographs of more than a hundred recoil tracks produced in an expansion chamber filled with nitrogen. He has observed another very interesting effect. In addition to the straight recoil tracks, he has obtained photographs of a number of branching tracks which indicate that the nitrogen nucleus has disintegrated in a novel way. These branch tracks are believed to be produced by the recoiling nucleus and by some particle which is ejected from the struck nucleus. The identity of this latter particle has not yet been definitely established.

It will take time to analyse the results

* *Nature* Vol. CXXIX, p. 312, 1932.

obtained, and to examine the effects produced in other gases. The peculiar properties of the neutron allow it to approach closely, or even to enter, nuclei of high atomic number, and it will be of great interest to study the effects of such collisions. It is, however, evident that this new radiation has surprising properties, and there is every promise that it may prove an effective agent in extending our knowledge of the artificial disintegration of elements. It will, for example, be of much interest to decide whether the neutron is captured in such disintegrating collisions, or whether it merely passes through the nucleus on which it has such a catastrophic effect.

Mme. Curie-Joliot and M. Joliot and Dee have independently noted that some swift electron tracks are observed in the expansion chamber. The exact origin and nature of these particles will require careful examination. It is possible that a γ-radiation is emitted from beryllium as well as the neutron. Mme. Curie-Joliot and M. Joliot found that the radiation from boron bombardment by α-particles behaved similarly to that from beryllium. It is possible that other elements will also give rise to radiations of this kind.

Whatever may be the final explanation of the interesting facts observed, it is clear that if they are due to a quantum of radiation, we must relinquish the laws of the conservation of energy and of momentum in the production of this radiation and its interaction with matter. If we wish to retain these laws, the neutron hypothesis seems the only alternative. In any case it is evident that these new discoveries have opened up a new region of research which is of great interest and promise.

Slides were shown illustrating the production of protons and nitrogen recoil atoms due to the radiation of beryllium, using both electrical methods and the tracks in a Wilson expansion chamber. Photographs were shown of electron tracks and also of the branching tracks believed to be due to the disintegration of nitrogen nuclei by the action of the radiation.

THE PLASTIC DEFORMATION OF METALS.*

By Professor Körber, Director, Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf.

Professor Körber explained how the use of industrial metallic materials depends to a considerable extent on their ability to suffer changes of shape—on their capacity to endure severe plastic deformation without any loss of internal cohesion. In mechanical-technical shaping processes (the most important of which are rolling, forging, pressing, drawing) the temperature at which the work is carried out is of great importance, since the ability to change the form, as well as the resistance to such alteration, which is determined by the power used in the deformation, are greatly dependent on this factor. Almost without exception deformation is facilitated by a rise in temperature.

A comprehensive insight into the processes of plastic transformation, and the deduction of the laws governing the latter, will be possible only if we possess for each individual process a clear and distinct picture of the stress relations and the manner in which the material flows. I take as a basis in the first place my own investigations and those of my colleagues which have been conducted during recent years in the Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf. I am conscious that the survey which is given of the researches which have been made into the mechanism of plastic deformation must in many respects remain incomplete.

Conditions for the Occurrence of the Plastic State.

For the characterization of the plastic processes those conditions are first of all of importance under which, with increasing stress, plastic deformations begin to occur in material primarily purely elastically stressed. For the proper understanding of these plasticity conditions those researches which have been carried out in this field of mechanical testing are of special importance. One important object of the latter

* Substance of the Twenty-second May Lecture to the Institute of Metals, London. May 11th, 1932.

is the determination of the limiting stresses which a test-piece may be able to endure without plastic deformation occurring. The methods of testing used in practice are intentionally selected so as to exert only a single type of stress; the test-piece is subjected as nearly as possible to pure tension, compression, or shear stress. Such simple and straightforward stress relationships are, however, never experienced in commercial shaping processes. Hence systematic investigations into the deformations arising from the action of a combination of forces, by which we may become acquainted with the nature and the state of the stress in a body, are especially valuable. Such researches enlarge our knowledge of the determinative laws, and must be considered the most promising way of developing the fundamental laws of a modern theory of tenacity. They may, especially, lead to a decision between the different theories which have been advanced with reference to the establishment of the plastic state.

The Mechanism of Deformation.

The expressions derived from the theory of elasticity and the theories of Hencky and Prandtl for the plastic state are in particular confined to such small alterations of shape that the original form of the test-piece may be regarded as unchanged. We have now to consider the nature of the technical manufacturing processes with direct reference to the change of external form. The methods of examination so far employed for these processes can yield only qualitative expressions. An exact mathematical analysis of the entire process of shaping is rendered possible by an accurate and detailed knowledge of the deformations that are produced.

A comparison of the initial and final dimensions of the stressed body, on the assumption that the change of shape is the result of a simple deformation on parallelepipedon planes, can serve only as a first rough approximation. That plastic deformation is a complicated process was recognized quite early, on the basis of observations on the commercial shaping methods, as well as on the deformation of stratified test-pieces, whether these were built up of plastic masses or of metal layers. In working, flat surfaces by no means remain always flat. In drawing, the outer zone is retarded in relation to the core, probably due to the effect of external friction on the die wall, so that a plane situated at right angles to the axis is distorted in a convex manner after the passage through the drawing die. Similar more or less marked distortions appear in other shaping processes.

In addition to the change in shape attained, which can be measured by the alterations in the external dimensions, other deformations become apparent in the interior of the material. They cannot be derived from the final dimensions of the piece which are the result of the working process. For the conduct of these technical operations they have, however, a certain importance, in that they involve an additional expenditure of power, to which I shall refer later on.

In the deformation of any type of composite test-piece, the fact cannot be overlooked that mutual displacements occur in the planes between the individual layers in consequence of active shear stresses, and that they modify the conception of the deformation.

That deformation in rolling is almost distortion-free is in complete agreement with the result of an X-ray examination undertaken in the Eisenforschungsinstitut, in which close relationships were revealed between the structure of a metal deformed by cold rolling and by parallelepipedial plane compression with unilateral flow of metal.

Power and Energy Demands in Technical Metal Working.

The exhaustive analysis of the processes of deformation which has been given renders feasible a more exact expression for the power or energy consumed in the carrying out of the technical working processes. The fundamental relationships between the resistance to deformation of the material, the roll pressure developed, and the output from the rolls were known long ago.

According to the relationships derived by C. Fink for rolling, the energy demand is calculated on the basis of pure parallelepipedial change in form, as the product of the resistance to deformation of the material and the "volume displaced. The latter is

given by multiplying the volume of the deformed body by the natural logarithms of the ratio of the dimension of the piece before and after the operation.

According to the shear stress theory, the resistance to deformation of a material corresponds with the constant maximum difference of two principal stresses, which difference determines the occurrence of plasticity. It is a property which suffers no change by hot-working during the transformation, yet is dependent on the working temperature and the speed of deformation, but which increases rapidly, however, with cold-working, according to the extent to which the form is changed (cold-hardening).

The energy and power required for the transformation, calculated according to these views, are only the lower limiting values to be actually used. In the first place, the augmented deformation due to the additional movements already mentioned demands an additional supply of energy; and in the second place, the friction between the tool and the work tends to increase the power and energy required.

The ratio of the theoretical expenditure of energy in loss-free deformation to the actual amount of energy employed constitutes the "efficiency of deformation" of the process concerned; this factor has proved a suitable standard by which to compare the values of a deformation process under different working conditions as well as those of different processes. In this manner the actual work of deformation has been calculated from the power transferred from the tool to the material. These power measurements have been made by the help of suitable measuring devices, which, in the case of drawing, were attached to the die-plate, and in that of rolling to the roll bearings. Losses of an electrical and mechanical nature depending on the method of driving the machine employed will not be discussed here. Valuable conclusions which bear on the construction and use of the machines may be reached from a determination of the efficiency. Only the actual losses incident to the working of the material will be further considered in this lecture. They may be divided into internal and external losses. The external losses are due to friction between the material and the surface of the tool; they are strongly dependent on the degree of lubrication, and may be derived only so far as the friction coefficient for conditions in the test concerned is known. The internal losses arise from the inner deformations already mentioned, which are in excess of the amount necessary for the development of the ultimate shape.

The results of the studies placed before you constitute without doubt a considerable enrichment of our knowledge of the technical processes of metal working. Nevertheless, we are still far removed from the control, in every particular, of the relationships and the laws which govern them, so that it is of value actively to pursue yet further our systematic researches into this sphere. There is no doubt of the great technical, scientific, and economic significance of the attainment of this object, for only by an exhaustive knowledge of all circumstances that are of consequence in the carrying on of the industrial working of metals, and by a complete appreciation of the various valid relationships between stress and deformation, will it be possible to ensure that these processes are conducted with the maximum of usefulness.

GREAT BRITAIN'S TRADE OPPORTUNITY.*

By Sir George Beharrell.†

I am glad that my first public speech as President of the Federation of British Industries should take place in Manchester, for a purely personal reason, that I am a North of England man myself—not a Lancastrian but a very near cousin—a Yorkshireman and although we all know how keen the rivalry is between the two Counties, yet it is a very dangerous proceeding for anyone to interfere in their private fights. Even roses have thorns! It is almost as risky as interfering between man and wife. But I know that this sympathetic audience will forgive any shortcomings in a mere Yorkshireman!

I feel it is fitting, as it is very pleasing to me, to be in Manchester because in

* Speech at Manchester, 31st May, 1932.

† President of The F.B.I., 1932/3.

spite of the difficulties of industry in this area, Manchester is still the strongest district in the Federation outside the Metropolis. I am not surprised at your local strength because Lancashire is notably a County where trade organization has been evolved to an extremely fine point and the need for efficient and enthusiastic organization is greater to-day than at any other time. There was always good reason for trades combining in order to be able to put forward their common views with that unity which is strength. How much more urgent and necessary to-day when we have to deal with a multitude of problems and questions which inevitably must emerge from the changes in the fiscal policy of the country. Arising out of that change in fiscal policy it seems to me clear and inevitable that H.M. Government will in time have to negotiate important commercial arrangements with foreign powers and the voice of industry as a whole must speak without faltering and hesitation concerning its requirements. Only through trade associations embracing a wide range of membership can such utterance be given in the most effective way.

Questions, however, will arise of a general character not appropriate to be dealt with by specialised trade organizations and the will and purpose of these organizations must be co-ordinated in a central organization if the voice of industry is to compel attention and command weight in the counsels of the Nation.

I am sure you will agree that the Federation of British Industries after 16 years of hard work can justify the claim that it has established itself in a position of influence and prestige which no central organization in this country has ever enjoyed before and we owe a debt of gratitude to those far-seeing men who started the movement in 1916 which resulted in the founding of this Federation.

That we are living in difficult times is evident in a thousand ways and it may almost be said that things are rendered more difficult by the confusion ensuing from the multiplicity of counsels offered almost daily as a certain remedy for our ills.

In the early years after the War I remember one distinguished economist saying that three years of bounteous harvest would put the world right and that we should be back to the conditions of 1913. Well, Mr. Chairman, we have had those years of bounteous harvest and what the world is suffering from to-day is an unprecedented glut of primary products and raw materials of every kind.

It reminds me of a cutting I took from a Canadian paper some months ago. It contained a statement attributed to Dr. Marvin. It reads something like this:—"Of old, man said that the Gods, jealous of his well being humbled him by starvation and want and gave him less than sufficient reward for his labour. When the Gods heard this they laughed; then they gave man more than he could use and still poverty and want were found in the land. Once again the Gods laughed." Life to-day is, in fact, a tragic and humiliating paradox—excessive supplies on the one hand and on the other hand a deplorable lack of prosperity and abnormal unemployment throughout the world. There never was a time when the interdependence of Nations was more important for the well-being of the world but owing to difficulties of one kind or another, intense nationalism is being developed and instead of each nation striving for interdependence, each nation is seeing how swiftly and completely it can make itself independent of any other nation.

We are on the eve of three most important Conferences. If those who have the responsibility for conducting these Conferences have the courage and ability to do what is right, it may be the beginning of a brighter era is at hand. But these are by no means the first Conferences which have been held since the War and we can only hope they will have a better fate than their predecessors. We look for better things, but frankly, I am not too sanguine, experience having made we wise.

Lausanne, which could be productive

of much lasting benefit to the world, is admittedly a somewhat doubtful quantity until the political situation in France becomes a little less obscure. Until a Government is formed with National backing determined to do the big thing it is difficult to see what can be achieved of real moment.

Geneva, again, is hampered by old rivalries and jealousies which stand in the way of real progress on the question of disarmament. A broadminded settlement on this question which would go far to ensure the peace of the world would have results which it would be difficult to measure. Whatever may be the results of these Conferences, there is still the Conference at Ottawa—a family affair—which is naturally most present to our minds at this juncture. On the other hand, being a family affair, and I use the world advisedly, it may be all the more necessary to bring to bear all the gifts of statesmanship which our Dominions, our Colonies and ourselves possess. At family conferences, plain outspoken words are often used but I am quite sure that the policies which are good for the family as a whole will command the most sympathetic and eager consideration.

Prosperity cannot come to the world simultaneously. It will begin in one territory or in a group of territories, Great Britain to-day has begun at last to find her feet. A distinguished foreign visitor was speaking to me the other day after completing a very extended tour of the principal countries of the World. He said, the most cheering sight he had seen in the whole of his tour was a shop window in Bond Street. Shown in this window were a few articles of gold but there were literally hundreds and hundreds of cancelled cheques which the firm had given in payment for gold. That shop window was a symbol to him of the great confidence of the British people. Instead of locking up their gold in strong boxes and hiding it in secret places, they brought it out into the light of day to assist in the stimulation of trade and industry. How different from the action in some Countries, where one Banker admitted that his most profitable business was the renting of Safe Deposits to the hoarders.

As I have said, Great Britain has begun to find her feet, and I think that is also true to some extent of our great Dominions Overseas.

Ottawa is an opportunity for achieving within the Empire some measure of that inter-dependence, co-operation and complementary trading which is essential for prosperity. It does not mean that this prosperity need be achieved at the expense of the rest of the world. In fact, a start on the lines I have indicated towards achieving a freer and a greater trade within the Empire would speedily have reaction in other parts of the world.

The success of Ottawa may mean a great deal to Lancashire, especially if the Government secures, as it should, a free hand in the Crown Colonies and makes the necessary revisions in respect of the African Treaties.

A great deal, however, will depend upon the spirit which prevails during this important Conference. If we begin with a spirit of haggling and hard bargaining, it may easily be another instance of "the mountain in labour bringing forth a mouse." I would rather see each member of that Conference approach it from the point of view of how much each can contribute towards the common good. In the language of the card table they would probably put up a "kitty" which would be astonishing. The problems are admittedly complex and each question has many sides. To expect a settlement of all these difficult problems at the one conference is to invite disappointment but it is not too much to hope that if we cannot garner the full harvest, we can at least reap something and leave the ground fertile for future harvests.

The problem to-day, is largely one of confidence. After all, credit is merely confidence expressed in a more or less tangible form and confidence will be more readily achieved when it is seen that the beginnings made by the National Government to balance our budget are brought to consummation. I am afraid a number of us have been deeply disappointed by one or two recent speeches of certain

members of the Government because they foreshadow doubts as to the budget balance, and from one quarter we even hear references to still further and ominous burdens. To me it is unthinkable to put any greater strain upon the sinews of industry.

Some questions may be controversial but the necessity for reduction in taxation needs no demonstration.

Frankly industry can stand no more taxation and I doubt very much its ability to continue effectively in operation on the present level of taxation. It is idle therefore for any Government to look to the balancing of the budget by further depleting resources of industry. The budget must be balanced from the other end. Expenditure must be reduced and by expenditure I do not mean the paring down of departmental estimates—one million here or two million there. The only way in which I see Government expenditure can be reduced to an extent commensurate with the most urgent demands of these present necessities is for the Cabinet definitely to review and consider the more expensive Policies and commitments.

It is true that some help can be forthcoming from the conversion of war debt and from any success which the Disarmament Conference at Geneva may achieve but the major relief for which industry calls, relief which is essential if unemployment is to be materially reduced, can only come from a definite change in Governmental policy.

The strictest and sternest thrift in expenditure by the Nation is of utmost importance and the same vigilance in expenditure by some Local Authorities is of no less importance, for the burden of rates has to be borne by industry to a very large extent and weighs heavily upon it and drastic changes of policy on the part of certain municipalities are called for.

Probably nothing has contributed more materially to the vast increase in expenditure by Local Authorities than the contributions from the Exchequer by means of percentage grants for certain services. You have in this the dangerous element of spending without restraint of the responsibility for finding the money and we all know how vicious that can become.

I am afraid too many men in business have been so overwhelmed by the need for closer attention to their business that they have not felt able to take that part in the administration of Local affairs which is necessary if the closest vigilance over expenditure is to be exercised. Local Rates and the proper and economical administration of local areas is a matter of the highest importance and I do hope that more and more attention will be paid to this matter.

When one sees lavish expenditure in the adornment of Housing Estates, already a heavy burden on the Rates, the houses being let at uneconomic rents, it makes one almost despair. I like to see well cut lawns, nicely trimmed hedges and shrubs and if we were on a wave of great prosperity, probably no exception need be taken but in these days this class of expenditure by the Local Authorities is totally unjustifiable. On one Estate I know of, the ratepayers are bearing a charge of £27 per house per annum.

I have merely given that as one instance, but I am quite sure every member listening to me could multiply the example many times over from his own experience.

I know that you are all anxious to get back to your duties. I know what a Tuesday in Manchester means as this is not the first "Tuesday" I have had the privilege of visiting your City, and I hope I have not detained you too long.

World conditions are anxious, perplexing, difficult, but we can congratulate ourselves on the position which Great Britain holds to-day. At one time there was danger lest other countries might be inclined to look upon this great country as tending to decline but you hear the praise of our renewed prestige as you travel about the world to-day.

If the Government will take its courage in its hands and deal with expenditure fearlessly as it should, our position in the world will get stronger and stronger.

THE ROYAL SOCIETY.

Thursday, June 2.

The David Ferrier Lecture:
Some Correlations between the Brain and the Skull.

By Professor C. U. Ariens Kappers.

While as a whole the correlation between the brain and the brain-case is such that the latter adapts itself to the form and growth of the brain, the author begins by giving some examples in which a one-sided external compression (Teleostomes) or a more general space economy in the neurocranium (birds) seems to be the primary factor in determining some external (and internal) morphological features of the brain.

He then discusses the brain and skull shape in mammals in relation to bodily characteristics and intrinsic changes in the brain itself, and their influence on the general and fissural aspect of the pallium.

Dealing briefly with the conditions in new-born mammals and man, he refers to the influence of early maturing fields (*Cunningham*) and of the "indice de valeur cérébrale" (*Anthony* and *Coupin*) on the general and fissural morphology of the brain.

Proceeding to the possibility of establishing anthropological differences in the brain, the author discusses the use of certain standard lines, angles and indices for expressing such differences in figures.

Starting with the chief components of the Dutch people, the mesocephalic Nordics, and brachycephalic Alphines, he mentions some variations in the general and fissural aspects of their brains correlated with the skull and probably depending primarily on the latter.

Applying the principle to other races, he first deals with the brain of the hyper-brachycephalic-hypsicephalic Armenians. So far as it is possible to infer from one Lebanese specimen, it seems that this brain closely resembles that of the Armenian. The peculiarities of these brains occur chiefly in the temporal and occipital fissuration, and seem to be correlated with the postauricular shortness—the occipital flattening shape of the skull so characteristic of these anthropologically closely related peoples. The author deals with the brains of some dolichocephalic races, such as the Egyptians and Sudanese.

He then proceeds to the general and fissural brain morphology of races in which, in addition to other features, the height index of the skull differs a good deal, and he compares the brachy-hypsicephalic Armenian with platy-brachycephalic Northern Mongol and the latter with meso- or subbrachy-hypsicephalic Chinese brain. Further, the Chinese brain is compared with the Japanese brain.

The very limited possibility of using the same standard lines for endocranial casts of extinct races is discussed. The brain (endocranial cast) of Pithecanthropus erectus *Dubois* is compared with the Chimpanzee's and Orang Utan's. Especial attention is given to the frontal region in these types and the errors in homologising the frontal fissures in Anthropoids and man. Correctness of ***Campbell's*** interpretation. Developmental changes of the frontal sulci in Neanderthal man and Homo sapiens fossilis.

Then will follow a discussion of the frontal region in recent man, especially Negro races, and the fissural changes in this region in connection with cytotectonic and functional fields, chiefly in the vicinity of the mid-frontal. Fragmentation of the latter. The phenomena observed in fissural development in general will be briefly discussed:. Firstly, confluence and adaptation, either as limiting or as axial furrows, as observed with the Rolandic (still represented by two fissures in Carnivores and in several Prosimiæ); the calloso-marginal (represented also by two fissures in several lower animals) and calcarine (represented by the retrosplenial and its processus acuminis in some lower mammals). Secondly, the tendency to fragmentation as observed in the midfrontal, inferior temporal and lunate.

The first process occurs in phylogenetically older regions that are becoming more stabilised, the latter predominates in or near regions of recent evolution. Comparison with cerebellar fissures.

The author finishes by stating that with the anthropological differences in the brain, which doubtless occur, we should try to differentiate between brain variations primarily depending on, or at least correlated with, the skull and intrinsic changes in the brain.

BRITISH ASSOCIATION OF CHEMISTS.

Manchester Section.

The Annual Meeting of the Manchester Section of the British Association of Chemists was held at the Grand Hotel, Manchester, on Wednesday, May 25th, 1932, Mr. E. N. Marchant being in the Chair.

In his Annual Report, the Secretary stated that in spite of the present economic conditions in industry and of the fact that a number of members who had lost touch with the Association had been written off the books, there was a welcome increase in the membership of the Section.

The programme of meetings during the year comprised the Annual Dinner, a Smoking Concert and one other, to which the Section had invited members of other Societies to hear a paper by Mr. H. T. F. Rhodes on "Science and Modern Society." Also, a meeting of members in North East Lancashire had been held in Accrington, and as a result, Mr. W. M. Coates had been appointed Consul in that area.

Mr. Rhodes, after referring to the good feeling which existed between the Section and other societies in Manchester, and to the extent to which co-operation between various Societies was taking place here in Manchester, expressed his appreciation of the manner in which the work of the Section was carried out.

The Officers and Committee elected were:—

Chairman: Mr. M. F. S. Choate.
Secretary: Dr. J. Avery.
Treasurer: Mr. T. O. Morgan.
Committee: Mr. H. Adams.
Mr. W. M. Coates.
Mr. J. H. Dent.
Mr. C. W. Doxey.
Mr. A. Gill.
Mr. A. Hill.
Mr. W. E. Kay.
Mr. E. N. Marchant.
Miss Rona Robinson.

who together with:—
Mr. J. T. Allpass. Mr. C. A. Mawson.
Mr. F. Page Evans. Dr. J. L. Hankey.
Mr. C. Garner. Mr. F. Sowerbutts.
constitute the new committee.

Mr. Marchant, in thanking the retiring members for their services, gave his opinion that the changes would prove to the advantage of the Section, and the business meeting closed with a vote of thanks to the retiring officers proposed by Mr. Gill and supported by Mr. Scholefield.

Mr. F. Scholefield then inaugurated a discussion on "Where does the Chemist stand to-day?" He urged Chemists to concern themselves with the world's economic problems, which would have to be solved by the application of scientific thought and methods. The advantages and disadvantages of Rationalisation were discussed and he pointed out that this ought to lead to amalgamation amongst Chemists.

Mr. Scholefield deplored the tendency of some firms to economise by cutting down research staffs, as business could not carry on unless research proceeded, and he stated that in only one country in the world had an organised attempt been made to deal with production on a national scale.

Dr. Hankey considered that the means of production were now so great that over production with resulting unemployment must follow unless the number of working hours, per week, be altered.

Mr. Mawson made a plea for inflation, stating that the economic problems would not be solved, until money was put in the pockets of the consumers, whilst Mr. Hill attributed the trouble to lack of confidence and too slow a circulation of money.

The advantages of a fixed programme of production were stressed by Mr. Barlow, and Dr. Ward commented upon the lack of appreciation of scientific method amongst people as a whole.

An alteration in the monetary system on an international basis was advocated by Mr. Rhodes, who also favoured a policy of scientifically controlled inflation.

A vote of thanks to Mr. Scholefield for his most interesting paper, proposed by Mr. Morgan and seconded by Dr. Hankey concluded a very successful meeting.

MINERALOGICAL SOCIETY.

Tuesday, June 7th, at 5.30.

Dr. Julien Drugman and Mr. M. H. Hey: Legrandite, a new zinc arsenate. Dr. W. F. P. McLintock: On the metamorphism produced by the combustion of hydrocarbons in the Tertiary sediments of south-west Persia. Mr. F. A. Bannister: Determination of minerals in the Transvaal platinum concentrates by X-ray methods. Mr. John Parry, Mr. Alpheus F. Williams and Dr. F. E. Wright: On Bultfonteinite, a new fluorine-bearing hydrous calcium silicate from South Africa.

UNIVERSITY AND OTHER NEWS.

Dr. Samuel Sugden, of Birkbeck College, London University, has received the title of Professor of Physical Chemistry in relation to his post at the College. Professor H. V. A. Briscoe, D.Sc., Director of the department of Chemistry, Armstrong College, Newcastle-on-Tyne, is coming south to London to occupy the Chair of Inorganic Chemistry at the Imperial College, South Kensington.

Sir John Russell, F.R.S., will receive the *Honoris Causa* degree of D.Sc. from Oxford on June 22.

Dr. H. W. Blood Ryan, the Editor of the *Chemical News*, has been invited to lead an astronomical observing expedition to Parent, Quebec, in connection with the August Eclipse. The expedition will comprise English and Continental members of the Faculty of Sciences, of which body he is this year's President. On Wednesday, August 31, observers will have the opportunity of witnessing one of the rarest, and perhaps the most magnificent, spectacles of nature—a total eclipse of the Sun. If the weather behaves, good photographs should be taken, but it unfortunately happens, that meteorology has not yet arrived at that same degree of accuracy in forecasting weather behaviour as has astronomy in forecasting eclipse. What records can be trusted, however, indicate a reasonable chance of clear weather along the path of totality.

SELENIUM IN CANADA.

Selenium is the latest addition to the numerous refined metal products now being produced in Canada. It is obtained as a by-product in copper refining and was produced for the first time in Canada early in 1931 at the plant of the Ontario Refining Company, Limited, Copper Cliff. When market conditions improve it will likely also be recovered at the new refinery of Canadian Copper Refiners, Limited, at Montreal East.

Canada is now in a position to produce selenium in large quantities but the market for any output is at present restricted, according to Arthur Buisson of the Dominion Department of Mines, Ottawa. Further researches to develop new uses will undoubtedly create a wider market for this relatively new commercial product.

Selenium is not very abundant in nature, although fairly widely distributed. It is found associated with sulphur compounds and often accompanies the sulphides of heavy metals in the form of selenides. In the electrolytic refining of copper it remains in the slime or residue from which it is afterwards extracted. In its metallic form it is characterized by a unique action toward light, which has made possible the development of the photo-electric cell or "electric eye."

Selenium finds its present chief market in the glass industry where it is used as a colourizer and for neutralizing other colours; it is also used in the pottery industry for the same purpose. In the manufacture of rubber products it serves as a vulcanizing and accelerating agent, and because of its reputed properties of increasing the resistance to abrasion of rubber up to as much as 80 per cent., it may have a large potential market in this industry. One of the most important potential uses is in the production of selenium cells for television transmission and reception. The normal price of selenium during 1931 was \$1.80 to \$2.00 a pound. It is generally sold either in the form of an amorphous powder, or as small rods and buttons.

Ottawa, *March 31st*, 1932.

CORRESPONDENCE.

The following letter has also been sent to the Journal of the American Chemical Society.

The Editor, *Chemical News.*

THE ESTIMATION OF IRON IN SOLUTIONS CONTAINING BOTH BIVALENT IRON AND TRIVALENT TITANIUM.

Sir:

It is known that sulfuric acid solutions of ferrous sulfate undergo oxidation but very slowly at room temperatures.[1] Thus, Baskerville and Stevenson[2] found that upon passing air for twelve hours through a sulfuric acid solution of Mohr's salt, there resulted but 0.0001 g. of Fe^{+++} out of a total of approximately 0.71 g. of Fe^{++}.

Furthermore, titanous sulfate solutions of ordinary acidity are extremely unstable in air. Thus, while reduction of titanium in the Jones reductor proceeds quantitatively to the trivalent condition, the deoxidized substance is usually collected under a protective solution, such as ferric sulfate, whereby the titanium is immediately converted to the quadrivalent state with the formation of an equivalent amount of the more stable ferrous sulfate.[3]

These facts, namely, the stability of acidified ferrous sulfate solutions and the instability of acidified titanous sulfate solutions towards atmospheric oxidation, suggested the possibility of estimating Fe^{++} in the presence of Ti^{+++} by subjecting the solution containing these ions to an air-bubbling process. It was hoped that in the time required to effect the complete oxidation of the Ti^{+++} the amount of Fe^{++} oxidized would be negligible, so that titration of the aerated solution with standard potassium permanganate would give a value corresponding to the iron alone.

This hope has indeed been realized and we have found that results obtained by the method outlined above are in good agreement with those obtained by the well-known method of Gooch and Newton,[4] wherein the Ti^{+++} is oxidised by bismuth trioxide, which does not affect the Fe^{++}, the metallic bismuth thus precipitated and excess bismuth oxide removed by filtration, and the filtrate, containing the Fe^{++}, titrated with standard permanganate in the usual manner.

Lundell and Knowles[5] have shown that sulfuric acid solutions of uranous sulfate, like ferrous sulfate, exhibit marked stability toward air oxidation, and we hope to employ our differential oxidation procedure in the evaluation of uranium in solutions containing U^{++++} and Ti^{+++}.[6] Other determinations, involving similar combinations, suggest themselves as possibilities in the further application of this method.

In the course of this work, a technique has been developed for the preparation of very pure solutions of titanic sulfate and titanous sulfate.

We expect to publish a complete account of this work in the near future.

1 McBain, *J. Phys. Chem.*, *5*, 623 (1901).
2 Baskerville and Stevenson, *American Chemical Society*, *33*, 1104 (1911).
3 Lundell and Knowles, *ibid*, *45*, 2620 (1923); *Ind. Eng. Chem.*, *16*, 723 (1924).
4 Gooch and Newton, *Am. J. Sci.*, *23*, 365 (1907); Newton, *ibid.*, *25*, 343 (1908).
5 Lundell and Knowles, *American Chemical Society*, *47*, 2637 (1925).
6 *Cf.* Newton and Hughes, *ibid.*, *37*, 1711 (1915).

7 J. T. Baker Chemical Company Fellow in Analytical Chemistry, 1930—1931.

DEPARTMENT OF CHEMISTRY
THE JOHNS HOPKINS UNIVERSITY
BALTIMORE, MARYLAND

WILLIAM M. THORNTON, JR.
REUBEN ROSEMAN[7]
SAMUEL I. KATZOFF

(Received 31st May, 1932.)

Notices of Books.

Laboratories. Their Planning and Fittings, by ALAN E. MUNBY, M.A., F.R.I.B.A. With an Historical Introduction by the late Sir Arthur E. Shipley, G.B.E., Sc.D., LL.D., F.R.S. Pp. xvi + 224. G. Bell & Sons, Ltd., London, 1931. 30s. net.

Every chemist dreams of the ideal laboratory where there is a place for everything and yet ample room, where he can command water, gas, steam, vacuum, pressure, electric light or power at a touch of the finger, and where the ventilation is adequate but not sufficient to blow a precipitate across the bench or to make the gas-flames shake. Few, however, are privileged to put their ideals into practice, and indeed it is no easy matter to do so. The various pipe lines have a habit of getting in one another's way, and an arrangement of benches and services which appears satisfactory on the plan may prove inconvenient in practice.

The harassed amateur laboratory designer will therefore turn in relief to the volume under review, which as a second edition, bears the hall-mark of reliability. He will enjoy the informal style of Sir Arthur Shipley's historical introduction, and he may even be tempted to read (or re-read) Browning's *Paracelsus* and so regain the atmosphere of the laboratory of the middle ages. It is interesting to note (and *Pepys's Diary* will supply further information) that Charles II had at Whitehall a "little elaboratory under his closet, a pretty place," and was working there shortly before his death. His researches are not widely known, but they appear to have been concerned mainly with the dissection of human remains.

The value of the book is greatly limited in one respect, for it refers almost wholly to laboratories for educational purposes where it is necessary to accommodate a large number of students doing the same work at the same time. Works' laboratories have problems of their own and must be planned accordingly, but the reader with interests in this direction must collect the information he requires from the various portions of the book and piece it together for himself.

The first chapter on the scope and inception of building schemes will interest all, for it deals with planning and arrangement, particularly from the architectural and structural points of view, and including such all-important matters as floors, the utilisation of old buildings, etc. Subsequent chapters discuss the requirements of Chemistry, Physics, Biology and Geology, respectively, most attention being paid to chemistry. It is advisable however, to study all four sections as they may often shed an unexpected light on a particular problem, *e.g.*, X-ray, centrifuge, refrigerator, autoclave and microscope rooms all come under Biology.

The next chapter deals in broad outline with the requirements for laboratory services, including ventilation, refrigeration, flues, drains, etc. Chemists in isolated districts where services such as gas and electricity are not available will not derive much satisfaction from the author's suggestions of alternatives. Indeed this chapter gives the general impression that the real problems of laboratory design are not fully appreciated, for example, no attempt is made to discuss the relative merits of taps, cocks, jets, switches and controls at the front or back of the bench or on the walls, and those chemists familiar with certain types of gas-cocks which seize up or which turn off when one leans against the edge of the bench will expect a discussion of these vital practical points. The designs of all these fittings should provide another useful subject for discussion, and instances could be multiplied.

The last chapter consists of plans with brief descriptions of special features and some details as to cost of a number of famous educational laboratories all over the world. In addition the book is illustrated abundantly with sketches and photographs, and if expensive is a handsomely produced and useful volume. It is to be recommended to all who think of installing or improving laboratories and indeed to every chemist who hopes one day to have the opportunity of realising the ideal laboratory.

JULIUS GRANT.

Il Polarografo, Sua Teoria e Applicazioni (The Polarograph, its Theory and Applications) by DR GIOVANNI SEMERANO. Pp. iv + 207 with 31 figures. Padua: Libreria Editrice A. Draghi di G. Randi Fu C. B., 1932. Price 16 Lire.

The subject of this book constitutes an example of the rapidity of modern scientific evolution. Some ten years ago there was no "polarographic" method nor did anyone suspect that the dropping mercury electrode, adapted by Kucera from Lippmann's capillary electrometer, would be capable of vast applications in chemical analysis. Nevertheless, this has been brought about in a remarkable way by Prof. Heyrovsky at the Charles University of Prague by introducing the dropping mercury electrode to electrochemistry by using it as a kathode and showing by means of a very sensitive galvanometer that the current which passes through this arrangement furnishes, in a strictly reproducible manner, an exact means for analysing the solution. This discovery in 1922 has since led to the publication of no less than 104 papers cited in the bibliography at the end of Dr. Semerano's monograph.

In order to record automatically the current voltage curves, from the shape of which many extraordinary deductions can often be drawn, Prof. Heyrovsky in collaboration with Dr. M. Shikata constructed the *Polarograph* machine, which continuously increases the polarising E. M. F. and records photographically the corresponding current. Through this innovation the electrolysing procedure has been considerably facilitated and become what is now called "the polarographic method."

Dr. G. Semerano, a skilful polarographist at the University of Padua, has collected in his book all the polarographic methods and theoretical deductions, giving a general survey of what has been done. After explaining the electrochemical and physical principles on which this method is based, the author proceeds to describe the apparatus and the numerous practical applications in analytical and physiological chemistry, biology, medicine and pharmacy as well as in industrial problems in the chemistry of sugars, fermentation products, petroleum industry, dyes, etc. Astonishing is the sensitivity of the method which reveals traces down to 10^{-6} gr. equivalent per litre, a volume of one drop being sufficient to carry off the electrolysis, which is qualitative as well as quantitative and simultaneous for several constituents.

From all we read in Dr. Semerano's book the manifold applicability of the polarographic method is most conspicuous, extending from purely theoretical precise investigations of over voltage phenomena and ionic equilibria to the quantitative determination of proteins and analysis of fermentation products. In many instances the method opens indeed quite new

aspects on processes at a polarised kathode as well as on kinetics of ionic splitting and catalysis at interfaces.

This monograph is, however, far from being a mere compilation. Thus the author proceeds further in the mathematical analysis of "polarographic," *i.e.*, current-voltage curves and adds in Chapter III, an original deduction and calculation of the curvature, taking new aspects of the relationship between intensity and resistance.

As a new science "polarography" has to be illustrated by many of the automatically drawn diagrams called "polarograms"; of these, indeed, some scores are well reproduced in the monograph, which is also adorned with a good photograph of the latest type of "polarograph," as manufactured by its Prague makers Dr. V. and J. Nejèdly.

In comparison with the booklet of V. Prát, published on the same topics in 1928 (Abderhalden's *Handbuch*) the monograph under review with its 207 pages indicates the rapid growth of the subject at the hands of Prof. Heyrovsky and his collaborators many of whom are now working with the method in all parts of the world.

Dr. Prát's monograph was in German, Dr. Semerano's is in Italian, but much can be readily followed by English readers and by consulting the papers given in the bibliography the importance of the subject should be appreciated.

New Patents.

These particulars of New Patents of interest to readers have been selected from the Official Journal of Patents and are published by permission of the Controller of H.M. Stationery Office, and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

Latest Patent Applications.

14,178.—Deane, G. N.—Hydrogenation of organic compounds. May 19th.

14,408.—Gire, G. & Fouquet, R.—Manufacture of magnesium. May 20th.

14,258.—Johnson, J. Y. (I. G. Farbenindustrie Akt.-Ges). — Manufacture of sodium nitrate from sodium bicarbonate.

Specifications Published.

373,029.—Metallges, Akt.-Ges.—Manufacture of sulphuric acid by the contact process.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, at the uniform price of 1/- each.

Group Abridgements can be obtained from the Patent Office, 25. Southampton Buildings, London, W.C. 2, either sheet by sheet as issued on payment of a subscription of 5/- per Group Volume or in bound volumes price 2/- each.

Abstract Published.

366,420.—Sodium carbonate and hydroxide; sodium nitrate, ammonium chloride; hydrochloric acid; catalytic oxidation of ammonia.—Mentzel, A., 2, Nordsternstrasse, Schöneberg, Bedlin.

In a process for the production of soda, sodium nitrate, ammonium chloride, and hydrochloric acid, solid sodium bicarbonate obtained by the ammonia soda process is converted into sodium cyanide by the action of carbon and nitrogen at high temperature, the cyanide is hydrolysed by treatment with steam to produce sodium hydroxide or carbonate and ammonia, the ammonia being partly returned to the ammonia soda process and partly oxidized to oxides of nitrogen which are reacted with further sodium chloride to produce sodium nitrate and hydrochloric acid. The soda or caustic soda produced in the hydrolysis step may be returned to the cyanidization step one or more times to increase the amount of ammonia produced. The oxides of nitrogen formed may be oxidized to nitrogen peroxide or converted into nitric acid before reacting with the sodium chloride. The oxidation of the ammonia to nitrogen oxides may be effected by passing an ammonia-air mixture over a heated iron-bismuth oxide catalyst.

The Latest Trade Marks.

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FARMOGLOSS.

531,129.—Chemical substances used in manufactures, photography or philosophical research, and anti-corrosives.—T. & W. Farmiloe Limited, 19 to 23, Rochester Row, Westminster, London, S.W. 1. May 25th.

VERUSOL.

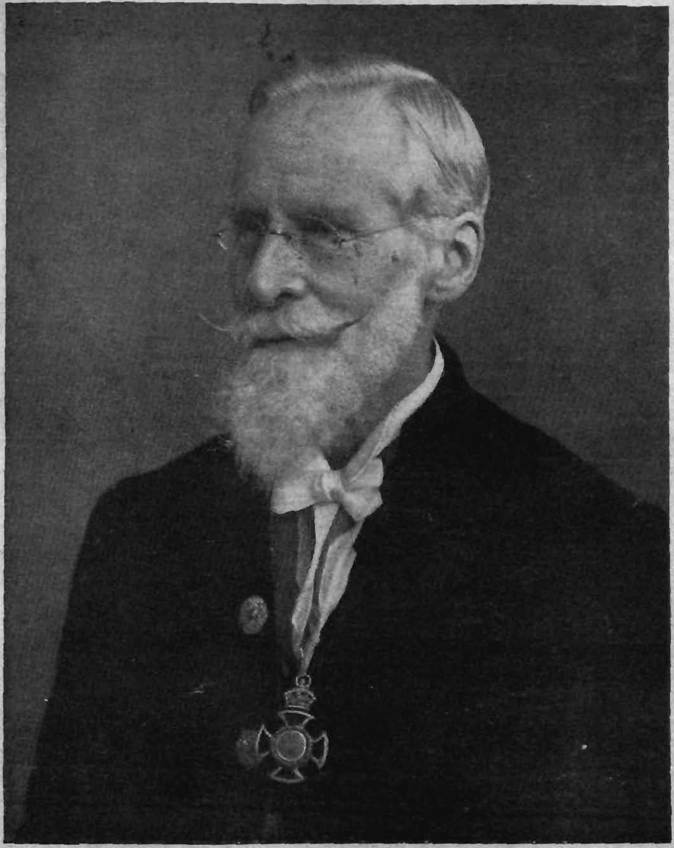
531,516.—Chemical substances included in Class 1, for use in the treatment of textile fabrics and leather in the course of manufacture. —*H. TH Bohme Aktiengesellschaft*, 29, Moritzstrasse, Chemnitz, Saxony, Germany. May 25th.

SANOPHONE.

529,987.—Chemical substances used for sanitary purposes.—Cleaners Limited, 109, Kingsway, London, W.C. 2. May 25th.

HEMWAY.

531,335.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Hemingway & Company, Limited, 28, Marsh Gate Lane, Stratford, London, E. 15. May 25th.



William Crookes.

THE CHEMICAL NEWS

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Edited by H. W. BLOOD RYAN, M.A., D.Sc., LL.D., Ph.D.

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Founder and Editor 1859—1919.

Sir WILLIAM CROOKES, O.M., F.R.S., D.Sc., LL.D.

One-time President of the Royal Society, British Association, and one-time Joint Secretary of the Royal Institution. One-time President of the Chemical Society.

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WILLIAM CROOKES—THE MAN AND HIS WORK
1832—1919

By H. W. BLOOD RYAN, M.A., D.Sc., LL.D., Ph.D.

As the present occupant of the Editorial Chair, *graced by Crookes for sixty years*, it is with diffidence and humility that I venture to pen these words.

In Homeric literature man is regarded as a union of two distinct entities, *viz.*, Body and Soul. Although the method by which the Soul at death passes into the unseen world is very crude and distinctly materialistic, yet Homer fully believed that the Soul was "the man," and therefore it was indestructible and immortal.

"There is no death! What seems so is transition,
This life of mortal breath
Is but a suburb of the life Elysian,
Whose portal we call Death."
(LONGFELLOW)

Crookes lives with us to-day—of the many amenities in life, how many owe their inception and in cases, development, to him? This very paper in which these words appear is very tangible evidence of his immortality. Truly Crookes could have said of himself, as did Horace,

"Exegi monumentum aere perennius
regalique situ pyramidum altius,
quod non imber edax, non Aquilo impotens,
possit diruere aut innumerabilis
annorum series nec fuga temporum.
Non omnis moriar, multaque pars mei
vitabit Libytinam; usque ego posteris*
crescam laude recens."

While it would be grossly unfair to later workers to say that our present knowledge of the structure of matter has been rendered possible by Crookes' early work, no one will dispute the fact that he played a giant's part in developing some theories that have induced others to follow and enlarge upon. Only a few weeks ago I received a letter from Lord Rutherford pointing out (when *speaking of Crookes) that in his lectures* at the Royal Institution this year, he reviewed Crookes' experiments on Cathode Rays *and the part that he played in the* ultimate advance which led to the discovery of the Electron.

To my mind, Crookes' endeavours were analogous to those of the founder of a dynasty. The dynasty holds sway, for a limited period, over a subject race but Crookes founded a new type of dynasty—that of intellect. The aristocracy of a ruling class in matters governmental can be sapped by the excesses of the race, but the aristocracy of intelligence descends, not by birth, but by selection. Admission into the ranks of this new aristocracy may be gained by all who will subject their minds to the necessary mental and physical endeavour to gain knowledge and truth. This new ascendant class has become mistrustful of the partisan politician, is filled with loathing at the suppression of truth for personal *pecuniary gain on the part of the* "big" man of business and frowns upon the moral suasion of the theologian in cloaking the *truths of existence for the sake of* "creed." Crookes was conscious of his mental capacity and rightly exerted his will on occasion. Because of this he was *called* a quarrelsome fellow—a despot, in fact in some quarters he was termed "an intellectual bully." He had a profound knowledge of his value, but seldom did it result in financial materialisation. If all our men of science were imbued with the idea of their real value, to-day we would not have so many sound chemists and physicists working for £200 a year.

Sir William Thomson (afterwards Lord Kelvin), said, after Crookes had delivered his inaugural address after his election to the Presidency of the Institution of Elec*trical Engineers in* 1890, that his speech had placed him "not second to Faraday, not second to Joule, but following both and *crowning both.*" *Thus spoke one great mind*

* "I have reared a monument more lasting than bronze and loftier than the regal pile of the Pyramids, such as neither the corrosive rain *nor the headlong north-wind can overthrow, nor* the countless train of years nor the flight of time. I shall not wholly die, but a great part of me shall 'scape Death; continually among posterity I shall increase fresh in fame."

of another, yet the lack of official commemorations of his birth would lead one to assume, that, apart from those scientists whose articles appear in this issue, there are "*none so poor to do him reverence*."

Crookes is the very type and symbol of English science at its best. His career embodies the emergence of the scientific man as a force in English life. He was not of the governing class. His education could not be Epitomised as of "Eton and Christchurch" or "Rugby and Trinity." According to early Victorian standards, he had no rightful part to play in English polity at all. His long life of 87 years saw the advance of science from the humble rank it held in 1832 to the all-embracing position it attained in 1919, and his own activities and achievements contributed not a little to the astonishing transformation.*

Crookes was born on June 17th, 1832, at 143, Regent's Street, London, W., and died on April 4th, 1919, at 7, Kensington Park Gardens, London, W. His father was named Joseph, and was a native of Masboro' in Yorkshire, born in 1792, yet again having as a father, a tailor. William's father came to London, married, and had 5 children by his first wife. He prospered in his business and became reasonably well-off, laying the foundation of a small fortune by investing his savings and profits in ground-rents. After the death of his first wife, Joseph Crookes then married Mary Scott of Aynhoe, Northamptonshire, and by her had issue to the number of sixteen, the eldest being William.

Now Mary Scott's (Mrs. Joseph Crookes) sister Martha, married a Mr. Geeves, a Bookseller, who lived next-door to the Crookes family. William, the subject of this article, naturally had access to the wide range of books and periodicals stocked by Geeves, thereby influencing, beyond doubt, his later search for knowledge and his printing, photographic and publishing activities. A diary belonging to Crookes' mother (*Marshall's Ladies' Daily Remembrancer*) has been carefully preserved. Under the date Sunday, June 17th, 1832, appears an entry in her own writing recording the birth of her illustrious William:—

"*Was taken ill between one and two o'clock in the morning. Baby born half past five in the evening.*"

When William was but a few days old, he received his first letter (from his Aunt Martha, Mrs. Geeves, living next-door), thus beginning a vast correspondence, greater probably, than that ever handled by any other scientific man. Aunt Martha's note ran as follows:—

"*Aunt Martha's kind love to her dear little nephew, and begs his acceptance of the 'World of Animals,' likewise a small purse which she thinks will be large enough to hold his money for the present anyhow*"

In 1837, Joseph Crookes appears to have prospered sufficiently to purchase Bute Cottage, near Regent's Park, and here William Crookes blossomed into virile boyhood. His early education was not extensive, though he attended a "College" at Weybridge, called Prospect House. A small trunk which contained his fresh clothes after each holiday, is still preserved by the family.

As history records, the marriage of Queen Victoria to the Duke of Saxe-Coburg in 1840, had far-reaching effects upon Anglo-German relations, especially in regard to scientific education, Germans flowing into England in great numbers especially after the "trouble" of '48, the revolutionary turning to the *hort der freiheit* across the German Ocean or North Sea. Consequently we find a young *Privatdozent* of Bonn University named August Wilhelm Hofmann inducted into the Chair of Chemistry and the "Headship" of the Royal College of Chemistry in Hanover Square, London.

William Crookes entered the College in 1848 and travelled daily from Brook Green Farm, Hammersmith (whither his family had removed from Regent's Park) in "the" omnibus, amid the turmoil of the Chartists' riots, then in full progress.

Among his fellow students was Bloxam, who, in after life, often remarked upon Crookes' painstaking care over experiments. Within a year at Hanover Square, Crookes had gained the Ashburton Scholarship and at the end of two years, Hofmann made him his junior assistant. In the following year Crookes became Senior Assistant to Hofmann.

* E. E. Fournier D'Albe. *Life of Sir William Crookes* T. Fisher Unwin, London, 1923. 30s.

a Fellow of the Royal Society, Williamson, Faraday, Gladstone, Tyndall, Brayley, Abel, Brodie and Matthiessen being among his sponsors. In 1864, he edited jointly with Samuelson No. 1 of the *Quarterly Journal of Science*. Then we find him thinking of setting up in Manchester, if he could have received the first refusal of the Honorary Chair and use of the laboratory of the Royal Institution of Manchester. This, *fortunately I feel for London, fell through*, and he turned his attention to explosives.

In 1864-5 he attempted to commercialize Sodium amalgam for use in gold amalgamation processes, but the use of KCN just about this time became very popular and thus killed any chance he may have had of success.

335,000 head of cattle were destroyed by a disease called by the Germans *Rinderpest*, during 1865-7 and Crookes worked with "that eminent chymist" Dr. Angus Smith, becoming obviously impressed with the necessity of a belief in infection by germs. *He had the greatest difficulty in getting his* methods used, *e.g.*, the use of tar-acids and SO_2 in disinfection.

In 1867, William Crookes was led to meet C. V. Varley, the telegraph electrician and spiritualist, by the death of Philip Crookes, his youngest brother (to whom he was deeply attached), at the age of 21, from yellow fever while on a cable laying expedition. Through Varley, he also became friendly with Huggins, who invited him to join an eclipse expedition. The object of the expedition was to study the corona and chromosphere. Crookes sailed with the party in H.M.S. *Urgent* on 6th December, 1870, but the Sun was thoroughly obscured by cloud during the whole period of totality. In the same year Crookes endeavoured, by psychic means to get in touch with his dead brother, Philip. 1870-1 saw two books published *Beetroot Sugar* and *Select Methods* and in 1872, he announced the atomic weight of thallium.

Between 1871-4 Crookes had many psychic experiences with the medium Home and Florence Cook.

From 1874-7 he carried out many and varied experiments on the behaviour of substances in vacuo when exposed to light. Then we find the invention of the Radiometer made public in a paper to the Royal Society on April 22, 1875, which caused an immense sensation throughout *the world*. Directly after this, Crookes received countless invitations from all sorts of learned (and un-learned) societies throughout the country asking him to give lectures and to name his own fee.

Thereafter, Crookes appeared to become *more prosperous, joining the Boards of* technical companies at quite good fees. He also sold his patent carbolic sulphite deodoriser for £2,200. About this time he also did a lot of useful work on sewage disposal and purification.

Then came his investigations into "The Fourth State of Matter."

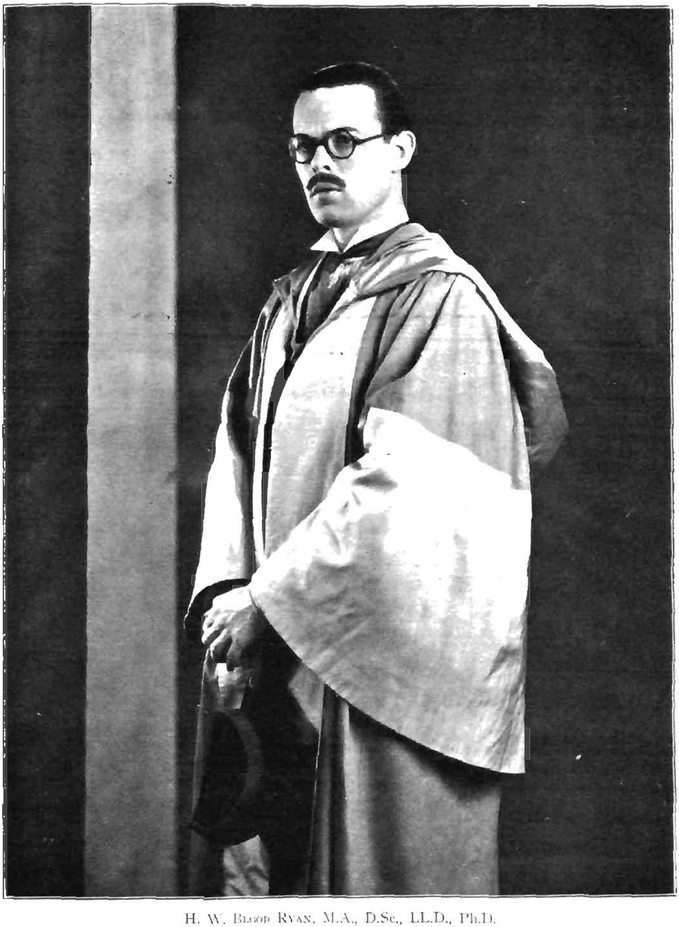
1877-9.

"In order to appreciate the transcendent importance of Crookes' experimental discoveries in high vacua, we must bear in mind that his earlier scientific training was acquired at a time when the leaders of science were *convinced that all really great* discoveries had been made and that nothing remained but to carry them 'to the next decimal place.' The doctrine of the conservation of energy had been thoroughly established, and had lent a sort of cast-iron consistency to a philosophic view of the Universe. The elastic-solid theory of light had been accepted as the true interpretation of all known optical facts, and the vortex theory of atoms promised to reduce the latter to mere modes of motion of an incompressible and all-pervading fluid. When Arthur Schuster in 1872 told the great Kirchoff of the discovery made in Ireland that light falling on selenium altered its electrical conductivity, the latter merely remarked 'I am surprised that so curious a phenomenon should have remained undiscovered until now.'

"In chemistry the atomic theory had become so firmly established that chemists spent years of work on 'exact' determinations of atomic weights—a pursuit which we now know to be futile."*

Even the great Todhunter declined to see an experiment shewing conical refraction because "it would upset all his ideas."

* Fournier D'Albe. *Life of Sir William Crookes.*



H. W. BLOOD RYAN, M.A., D.Sc., LL.D., Ph.D.

The present Editor of *The Chemical News*, President of the Faculty of Sciences, Vice-President and Hon. Foreign Secretary for Europe, Muslim Association for the Advancement of Science, Consulting Professor of Physical Chemistry, Cornell College, U.S.A., etc.

William Crookes was the first man to produce a vacuum containing only one part in 10^6 of air (1-1,000,000). In 1877 we find sundry letters passing between Crookes in Paris and his financial agents in London, culminating in his making some money owing to an intelligent anticipation of the movements of the French elections. This instance is typical of Crookes. He essayed to venture now and then into *haute finance*, usually only to burn his fingers. About this same time (1878) he sent a paper to the Royal Society "on the illumination of Lines of Molecular Pressure and the Trajectory of Molecules," being really the first description of the phenomena subsequently known as "Radiant Matter."*

Arising out of this paper came the famous Bakerian Lecture and the lecture at the Royal Institution, and his address to the British Association at Sheffield on April 4th, 1879.

Crookes was now 47 and the remaining years of his life were spent in consolidating what he had built, turning his attention especially to electric lighting problems. Came the era of electrical illumination and Edison's master patent.

Then he was forced again to the fray. Roscoe attacked his atomic weight of Thallium and having disposed of this argument in his inimitable manner, he began again to enter commerce, being appointed a director of the Alizarine and Anthracene Coy. at £50 per year and one guinea for each meeting attended.

Prosperity coming upon him apace, he moved to 7, Kensington Park Gardens, in 1880, remaining there until his death. Incidentally, his was the first home in England to be fitted with electric lighting. He also fitted up a good research laboratory in his residence.

In 1881 Crookes patented his electric lighting devices and after a valiant attempt to secure the market his ready perception saw looming in the future, he gave in and sold his rights. But for this, he might have died a millionaire. The fault with Crookes lay in the fact that he was not sufficiently unscrupulous to be a successful man of affairs. The Jury of the Electrical Exhibition in Paris of 1880 said "None of them . . . . Edison, Swan, Maxim, or Lane-Fox . . . . would have succeeded had it not been for those extreme vacua which Mr. Crookes has taught us to manage." Crookes became Chairman of the Notting Hill Electric Light Coy. in 1891 and remained in office until 1905, piloting the Company to success. He carried out experiments on the viscosity of gases at high exhaustions and in 1881 read his papers before the Royal Society. Then his Cathode Ray work on rare earths occupied his attention until 1885, when he announced the discovery of nine new elements, none of which were confirmed.

He next turned his attention to the water supplies of London, continuing this type of work right up until 1913. The back numbers of the *Chemical News* of this period abound with reports thereon, the work being carried out with the collaboration of Tidy, Odling and later Dewar. In 1886 he became President of the Chemistry Section of the British Association, and his address referred to Proust's hypothesis, believing that the common primitive and original substance* from which all elements were derived to be what he called, *protyle*.

In 1888 Crookes, moving with the times, bought a Hammond typewriter and soon became an adept, and in the following year, he was induced by Mr. Horatio Bottomley to join the Board of Kegan (Paul) Trench, Trübner & Co. In replying for the medallists on the occasion of his award of the Davy Medal, at the Royal Society, he elaborated a theory of "meta-elements" mentioning the lack of observation of an element in process of transmutation. From the letters, we find that on this occasion and on most similar occasions thereafter, he submitted his notes to a Miss Alice Bird, his "muse," who seems to have been responsible for giving a high literary merit to them. Crookes always affectionately referred to her as "my dear Lallah" in his letters and

* Now known as "Cathode ray phenomena."

* In later years Crookes acknowledged his inaccurate spelling, pleading the ignoring of the *spiritus asper* in the Greek. The word should have been *Prothyle*. πρωτηυλη.

with Lady Crookes, was on terms of closest friendship with her and her brother, Dr. Bird of Hampstead. With his mind still bent on gold extraction processes he acquired a Welsh Gold Mine, but although some gold was actually extracted by his systems, he sold the mine the following year.

Again Crookes embarked upon the sea of high finance in his frail boat "Bitter Experiences" and was persuaded by A. P. Sinnett, the theosophist to underwrite Mr. Horatio Bottomley's "International Newspaper Coy." Things looked nasty, but Mr. Bottomley came to the rescue and treated Crookes handsomely and all was again well. Back to science for Crookes.

In 1893-4, we find William Crookes appearing for the Crown in the great Cordite Case, *Nobels* v. *Anderson*, receiving a fee of £500 for his evidence. About the same time he forecast wireless telegraphy.

Argon was isolated simultaneously by Ramsay and Rayleigh in 1894 and it fell to Crookes to prove its identity by examination and comparison of the spectra of samples. His cryptic reply to Ramsay on the matter is too well known to need any elaboration here. In 1895 Crookes verified Lockyer's "helium," publishing a paper on its spectrum in *Nature* (of which Lockyer was then Editor) and in the *Chemical News* during the same week.

In 1895 he visited South Africa in order to give evidence for the African Gold Recovery Company and while there he combined business with pleasure, visiting the diamond mines at Kimberley and lecturing thereon upon his return to England.

In 1897 Crookes became the President of the Society for Psychical Research, and a perusal of the list of that society's Presidents will show that he was no fanatic when we consider that such men as Lodge and Flammarion have since occupied the chair. During the same year, which was the occasion of Queen Victoria's Diamond Jubilee he received the honour of Knighthood, but it is certain that in his heart of hearts, whilst paying dutiful lip service to Her Majesty for the honour bestowed upon him, he really felt something like a small-town mayor. Whilst the honour in itself was Royal recognition, it most certainly did not place him in that proper rank of nobility to which he (I suppose) felt he belonged. From this time until 1903, Universities showered their degrees *honoris causa* upon Sir William Crookes—whether it was because they felt it encumbent to follow the Royal lead in recognition or whether it was a spontaneous effort is a matter known only to the Senates of the respective institutions. From the circumstances, either inference can be drawn; most certainly Crookes was correct in categorising such Academic distinctions as "dust and ashes," when is considered the relative value of the degrees to him then and what great assistance they would have been had they been bestowed 25 years earlier, when he was seeking appointments. In the same year he acted as mediator between Ramsay and Dewar, over their respective claims to Presidency of the Chemical Society, and in the following year he was the President of the British Association, when his epoch-making speech on wheat shortage was delivered at Cardiff. The printed copies of this speech are still in great demand by those students of the subject, because he formulated an estimate of the world's supplies (modified of course by the events of years). Sir William Crookes, in uttering the warning was only doing his duty to his country and the world. The need for that warning is best evidenced when we remember that the consumption of nitrogeneous fertilizers rose from 300,000 tons in 1898 to 1,721,000 tons in 1930-1.

Crookes said "The fixation of atmospheric nitrogen is one of the greatest discoveries awaiting the ingenuities of chemists." By the events of this century we know that the chemists, ably assisted by the engineers have amply justified his expectations in accepting his challenge and proving their ability. The strain of dignified humour running through his make-up is exemplified in grant of arms after Knighthood had been conferred upon him. His choice of arms were, four prisms—symbols of the spectroscope, as well as a radiometer. The device was the perpetration of a sort of heraldic pun on the College of Arms:—

Ubi Crux Ibi Lux.

" *Ubi Crookes Ibi Lux.*"

This early caricature by "Spy," the famous cartoonist of the late Victorian era, of Sir William Crookes, shows him in a characteristic, though unconventional pose. His face discloses the great satisfaction he feels in holding a vacuum tube which he hoped would bear his name for years to come—a hope justified by events and enjoyed by Crookes. The title is exceptionally witty, being a pun on his grant of arms. If only this caricature remained in existence, we should still have rather a full story of Crookes and the Crookes' tube.

I am able to reproduce this caricature only by the courtesy of Dr. Neil E. Gordon, the Editor-in-chief of the *Journal of Chemical Education*, of the American Chemical Society, it having appeared in that journal in November 1931.

In the Jubilee year Crookes gave a lecture at the Royal Institution, supported by experiments, on the production of artificial diamonds. Owing to an accident with the crucible the experiment was not successful and although the lecture was very enjoyable and certainly remarkable, one of the morning papers (I suppose the caption writer was in facetious mood that day) headed its notice of the lecture *How Diamonds are Not Made*.

In 1900 Sir William became an Honorary Secretary of the Royal Institution. About this time Crookes had occasion to write to *The Times* pointing out that his name had an "e" in it . . . . and he was *not* William Crooks, the Labour man. This naturally annoyed Crooks somewhat, but the two concerned patched the matter up gracefully. The title of his address before the Congress of Applied Chemistry in Berlin in 1903 was "Modern Views on Matter: The Realisation of a Dream" and a study of this paper will show his patriotism over the dye question.

The work he and Dewar carried out in connection with water supplies resulted in large amounts piling up to their joint credit, but also difficulties existed in their collection; Lambeth especially seeking to secure reductions of their joint charges, culminating in considerable unfriendliness between them and the Companies. Since 1898 Crookes had been a member, with Rayleigh, Noble

and Haldane, of the Explosives Committee of the Ordnance Board, and upon its reconstruction in 1906 he was given a salaried appointment. A German, Dr. Silberrad was head of the laboratories and of him Crookes had an extremely high opinion and strove to keep him for this country.

In 1904 Sir William received the Copley Medal of the Royal Society and in the following year he again visited South Africa, this time with the British Association, lecturing on Diamonds.

Sir William and Lady Crookes celebrated their Golden Wedding in 1906, and at the celebrations the affection each had for the other impressed all who were present.

In August 1908, he wrote the obituary notice of Henri Becquerel for the Royal Society, which is a charming narrative of many aspects of radio-activity as then known. He received the Curies' work on spontaneous heat with an ultra-conservatism (which to me seems foreign to the character of the man), and in a letter to another Fellow of the Royal Society, said "a few decigrammes of radium have undermined the atomic theory of chemistry, revolutionised the foundations of physics, revived the ideas of the alchemists, and given some chemists a bad attack of 'swelled head.'"

In the same year Crookes invented the Spinthariscope, a little instrument now known to all physicists; the election to the Foreign Secretaryship of the Royal Society also became his portion in this year.

In 1909, *The Chemical News* completed its hundredth volume and in a letter to Miss Bird he wrote "and I think it will be legitimate to indulge in a little cock-crowing on the occasion."

The King bestowed the much coveted and jealously guarded Order of Merit on Crookes in 1910 and he appeared to appreciate this more than his knighthood. On November 11th, 1910, his speech at a banquet given to Past Presidents of the Chemical Society was remarkable, and a few days later at the Institution of Electrical Engineers he indulged in some lively recollections, "I have heard 'God Save the King' before Victoria's reign, and . . . . re-make the acquaintance of an old friend, Halley's Comet, which I saw on its appearance in 1835."

In 1911, a quarrel over a discovery of colloidal metals by Crookes' Son, Henry broke a life-long friendship between Sir William and Dewar.

In 1913, the greatest honour that can fall to an English man of science, became his, when he was elected the President of the Royal Society, which exalted position he occupied for three years. The scientific world had no further honours to bestow and he was entitled to enjoy (?) the "twilight of the Gods." It is true that for the remaining six years of his life he basked in the warm affection of an appreciative public, but—the War Gong sounded in 1914, when he was in the country. Back into harness went this valiant soul, throwing the whole of his energy into the service of his country. Despite the throes of enmity in which England and Germany were suffering, the humanitarian comes out in Crookes in the following:—"The Royal Society is always cosmopolitan in spirit, and we should be unworthy of our heritage could we not even at this desperate moment, take a dispassionate view of events, and preserve a well balanced and rational attitude towards our contemporaries of German nationality."

Crookes was given the general supervision of four War Committees of the Royal Society, set up to advise the Government on scientific questions, and in 1915 joined the Admiralty Board of Invention and Research.

About now his health began to fail, and in 1916, only a few days after the occasion of their diamond wedding, the life partnership was broken by the death of Lady Crookes. Sir William was grief-stricken and took recourse to mediums in order to keep in touch with his beloved. He appears to have found some consolation and whether or not he was imposed upon by fraudulent mediums, it is impossible for us to say. "There are more things in Heaven and Earth . . . ." Perhaps, had Crookes succeeded in persuading the Royal Society, in his early attempts at proving scientifically psychical phenomena, to discuss his theories, a different aspect would present itself. This is not the time nor the forum in which to discuss such problems.

He perfected his "eye-preserving" glass in the Summer of 1917, resulting in "Crookes" lenses. This work was, primar-

ily designed for the protection of workers in glass.

With the waning of the flame of life and war conditions in London, Crookes did not mingle much with his old colleagues. In 1918, he prepared some compounds of Scandium for the British Scientific Products Exhibition and on December 10th he sent a paper to the Royal Society on Scandium with photographs of its spectrum.

At six o'clock a.m. on April 4th, 1919, the great and simple soul passed to its final rest. At his death England and the World lost one of its greatest men. His earthly remains were interred at *Brompton* Cemetery, mourned by a large gathering of friends and influential representatives of the leading scientific societies.

THE ARTIFICIAL TRANSMUTATION OF ELEMENTS

By LORD RUTHERFORD, O.M., F.R.S., M.A., D.Sc., LL.D.

The proof by Crookes that the Cathode Rays consist of a stream of negatively charged particles projected from the cathode formed an important step in the scientific advance which ultimately led to the discovery of the electron. He was the first experimenter to devise methods of measuring very low pressures and to estimate the mean free path of the atoms in the discharge tube. It is thus appropriate that in the Crookes Centennial number of the *Chemical News*, which he founded and edited for so long, that a brief review should be given of the development of high vacuum methods to produce streams of swift electrified particles in order to test whether the atoms of matter can be transmuted under the influence of this violent bombardment.

The possibility of the transmutation of matter has always exerted a strong fascination on the scientific mind and much influenced the early stages of the development of science. We now know that the physical and chemical methods employed in the early attempts to produce transmutation were quite ineffective for such a purpose. A definite attack on this problem has had to await a clearer understanding of the structure of the atom and the development of methods for detecting individual atoms of matter in swift movement. The proof that the heavy radioactive elements were undergoing spontaneous transformations was a great step in advance and revived the dormant interest in the problem of transmutation. The study of these transformations gave us for the first time some idea of the powerful forces that must exist within the structure of atoms.

The atoms of the radioactive elements break up with explosive violence with the expulsion in most cases of a swift α-particle (helium nucleus) or in others with the ejection of a swift electron (β-particle). As the result of this explosion the resulting atom has entirely different physical and chemical properties. It may in turn break up and a whole series of successive transformations may occur. In this way more than thirty new transition elements of limited life have been brought to light. The processes occurring in the radioactive atoms appear quite uncontrollable by any physical or chemical agencies at our command. We can only watch the explosions of these atoms but are powerless to influence them.

The α-particles emitted from radioactive bodies are the most energetic projectiles known to science. They move so swiftly and have so much energy of motion that they can penetrate freely through the outer structure of the atoms but suffer marked deflexion from their

path if they approach closely to the minute charged nucleus which is a characteristic feature in the structure of all atoms. Indeed it was from observations of the number and magnitude of these deflexions that the conception of the nuclear constitution of atoms first arose. These deflexions allow us to form some idea of the dimensions of the nucleus itself at any rate in the case of the lighter atoms. It has been found that the radius of the nucleus, assumed spherical, must in general be very small, lying between 10^{-12} and 10^{-13} cm., so that the volume of the nucleus is minute compared with that of the atom itself as ordinarily understood.

It is important to emphasise a clear cut distinction between the nucleus and the planetary electrons which surround it at a distance. By the action of light, X-rays, or by collisions with swift α- or β-particles, one or more of these outer electrons may be readily removed and indeed it is possible in some cases to strip the lighter atoms of all their outer electrons. By this loss of electrons, the ordinary physical and chemical properties of the atom are profoundly modified for the time, but yet at the earliest opportunity the nucleus captures new electrons from its surroundings and these take the place of the lost electrons. The atom thus regains its original state and no permanent change in the atom has been effected. If we wish to effect a veritable transmutation of the atom, it is necessary to alter the charge on the nucleus or, what is equivalent, to remove one of the charged units which make up the structure of the nucleus itself.

It is believed that the two primary units comprising the nucleus are electrons and protons but there is strong evidence that secondary more complex units may be formed by the combination of protons and electrons. The most important secondary unit is the α-particle, consisting of a combination of 4 protons and 2 electrons, and recently evidence of the existence of a neutron—a close combination of a proton with an electron—has been obtained. Both of these secondary units may form an essential part of the nuclear structure.

While the nucleus of an atom is a minute and strongly guarded structure, yet is seemed likely that a very swift proton or α-particle might be able to penetrate the nucleus of the lighter atoms and to alter its charge and mass. Following out these ideas Rutherford, in 1919, bombarded nitrogen gas with swift α-particles from radioactive substances and found that high speed hydrogen nuclei, or free protons as we now term them, were liberated. For every 100,000 α-particles which pass through the gas on an average only one swift proton was liberated. It was shown that these swift protons could only arise as a result of a close collision between the α-particle and the nitrogen nucleus. This was the first time that definite evidence had been obtained that an atom could be transmuted by artificial methods. In subsequent experiments, by Dr. Chadwick and the writer, it was found that a number of the lighter atoms could be transmuted by α-particle bombardment. In all cases a proton was liberated with characteristic maximum speed and in the case of aluminium the energy of the ejected proton was greater than the energy of the bombarding α-particle. Certain light elements like lithium, carbon, and oxygen appeared to be unaffected by α-particles.

The mechanism of this method of artificial transformation of atomic nuclei was brought out clearly by Blackett who obtained direct evidence that in the case of nitrogen the colliding α-particle was captured by the nucleus, the disturbance resulting in the ejection of a proton. Since the α-particle has a mass 4, and charge 2, the nitrogen nucleus of mass 14, and charge 7, is transformed by the capture of an α-particle and loss of a proton into a new element of mass 17 and charge 8, or in other words, into an isotope of oxygen. Subsequently a stable isotope of oxygen of mass 17 has been found to exist in ordinary oxygen. General evidence indicates that the transformation affected by α-particles in other light elements is similar in character. It

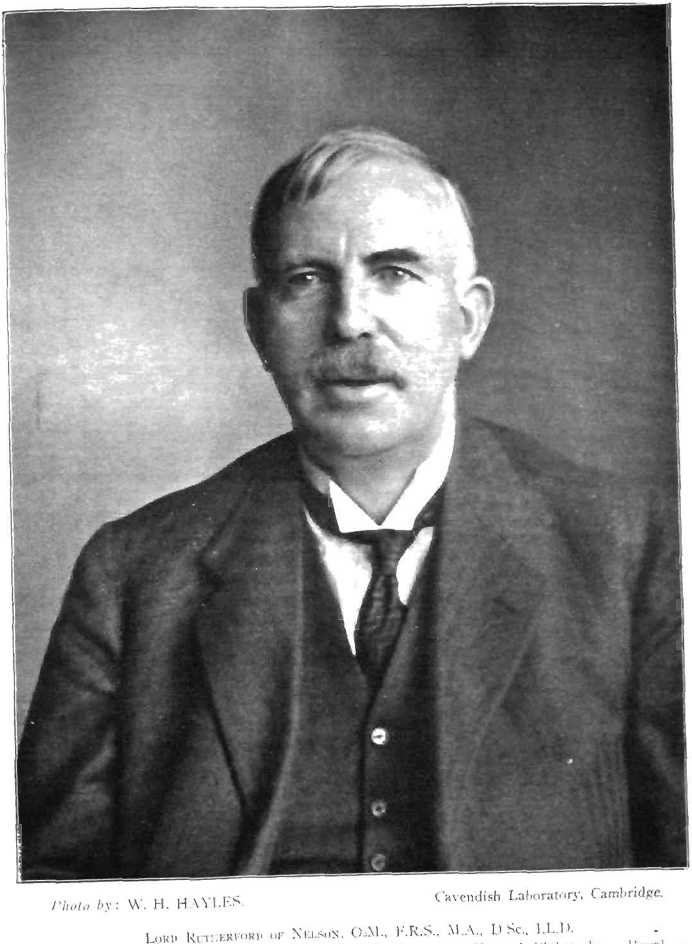


Photo by: W. H. HAYLES. Cavendish Laboratory, Cambridge.

LORD RUTHERFORD OF NELSON, O.M., F.R.S., M.A., D.Sc., LL.D.

Cavendish Professor of Physics, Cambridge. Professor of Natural Philosophy, Royal Institution. Nobel Prizeman. President, British Association, 1923. President Royal Society 1925-8.

is thus clear that the effect of α-particle bombardment leads to the building up of a heavier nucleus with an increase of 1 in the nuclear charge, and an increase of 3 in the mass.

During the last few months, the experiments of M. and Mme. Joliot and Dr. Chadwick have disclosed a new kind of transformation brought about by the bombardment with α-particles which occurs in the light elements beryllium and boron. It has been found that when beryllium is bombarded with swift α-particles no protons are emitted but instead a stream of swift uncharged particles of mass about 1, "neutrons" as they have been termed. The neutron has very interesting properties, for it passes freely through the atoms of matter in its path and only shows its presence when it collides directly with an atomic nucleus. In such a case the struck nucleus recoils and is detected by the dense ionisation it produces in its path before being brought to rest. There is evidence that the neutron, unlike the α-particle, proton or electron produces very little ionisation in its passage through a gas, so that its presence can only be detected on the rare occasions when it strikes the nucleus of another atom. It is probable that the nucleus of beryllium of mass 9, and charge 4, captures the colliding α-particle and ejects a neutron with high speed. The atom of beryllium is thus transformed into an atom of carbon of mass 12, and charge 6. Feather has shown that the swift neutron also produces a novel type of transformation in nitrogen. In many cases an α-particle, not a proton, is ejected from the nitrogen nucleus. It will be of much interest to test whether the neutron is able to produce a transformation in other light elements besides nitrogen.

Since the nuclei of the atoms are very minute, it is only on rare occasions that the α-particle approaches closely enough to a nucleus to effect its transformation. For example, for every million α-particles fired into aluminium on an average only one is effective in causing the ejection of a proton from the aluminium nucleus. Even with the strongest sources of α-particles available in the Laboratory, the effects observed are on a very small scale and detailed investigation has only been rendered possible by the development of powerful electric methods for registering the entrance of each individual proton into the detecting chamber. Progress in this problem would be much facilitated if far more powerful sources of swift bombarding particles of different kinds could be obtained by artificial methods. The importance of developing such new sources has been recognised for some time and many Laboratories throughout the world have been trying out methods to achieve this purpose.

A suitable way for obtaining protons in great numbers is to pass an electric discharge through gas at a low pressure. For example, the passage of a current of 1 milliampere through the tube corresponds to the bombardment of the cathode by about 6×10^{15} protons per second. To obtain an equal number of α-particles we should require more than 100,000 grammes of radium. The speed of the protons generated in an ordinary discharge tube would, however, be much too slow to be effective for our purpose. In order to increase the speed it is necessary to arrange that the protons should pass into a chamber, which is kept exhausted to a high vacuum by means of powerful pumps, and to apply a high potential to the ends of the chamber. The protons are thus accelerated in their passage through the intense electric field and for a potential difference of about 1 million volts acquire a speed comparable with that of the α-particles spontaneously emitted from radioactive substances.

During the past four years, Dr. J. D. Cockcroft and Dr. E. T. S. Walton have been preparing an installation in the Cavendish Laboratory to try out this method. Starting with a transformer which gives 200,000 volts, they have by special devices been able to obtain a steady D.C. potential of about 700,000 volts. This is applied to a large vacuum tube in which the protons are accelerated. Experiments were first made to determine the velocity and power of penetration of the swift protons produced in this

way. It was found that, using 600,000 volts, the protons were stopped after their passage through about 1 centimetre of air. Experiments were next made to test whether any swift particles were liberated from elements by this proton bombardment. The material to be bombarded in the form of a disc was placed at an angle of about 45° with the direction of the proton stream and the particles to be examined passed outside the tube through a small opening which was covered with a thickness of mica sufficient to stop any primary protons which fell upon it. For the detection of swift particles, the convenient and well known scintillation method was first used, a zinc sulphide screen being placed close to the opening. The number of scintillations were counted with a microscope in a darkened enclosure.

Using a lithium target, a number of bright scintillations like those produced by α-particles were at once observed. The number was proportional to the proton current and increased rapidly as the accelerating voltage was raised. Using a proton current of about a micro-ampere, a few particles were observed for as low a potential as 100,000 volts and a large number at 600,000 volts. In later experiments these particles have been examined by electrical methods as well as by the scintillation method and there appears to be little doubt that they are α-particles which are liberated from the bombarded lithium. The particles have a definite range in air of about 8 centimetres and thus have greater swiftness than the α-particles spontaneously liberated from radium C, which have a range in air of 7 centimetres. It can be deduced that the energy of the α-particle from lithium is about 8,400,000 electron volts while the energy of the bombarding particles may be as low as 100,000 electron volts, but it must be borne in mind that many millions of protons are required before one is effective in promoting the disintegration of the lithium atom.

From these observations, it seems likely that a proton is occasionally captured by the lithium nucleus of mass 7, and charge 3, giving rise to an unstable element of mass 8, and charge 4, which immediately breaks up into two helium nuclei each of mass 4. If momentum is to be conserved, it is to be expected that the two helium nuclei should fly off in opposite directions, the correctness of this view admits of a simple experimental test which no doubt will be made in the near future. It is natural to suppose that the lithium nucleus of mass 7, normally consists of 1 helium nucleus, 3 protons and 2 electrons. The capture of the bombarding electron in some way results in the combination of the 4 protons and 2 electrons to form a new helium nucleus or α-particle. It may be that the α-particles, which are believed to be the main constituents of the heavier nuclei, are always formed in situ within the nucleus itself. On the views outlined, the energy emitted during the transmutation of lithium is consistent with the conservation of energy as well as of momentum. The mass of the lithium nucleus together with the mass of the swift proton is greater than the masses of the two α-particles into which it breaks up. On the Einstein theory, a decrease of mass in a system involves a liberation of energy in some form. Calculation shows that the energy of motion of the two α-particles into which lithium disintegrates is in approximate accord with that calculated from the change of mass involved. The whole process is thus consistent, as far as observation has gone, with the conservation of energy.

Preliminary observations have also been carried out on the effect of bombardment of other elements by protons. Boron, fluorine, aluminium all give particles resembling α-particles which have a definite characteristic range in air. Similarly, some particles are ejected from beryllium, carbon, nitrogen, calcium, potassium, iron, nickel, cobalt, copper and silver, while the heavy elements lead and uranium show some effect. The number of particles liberated varies markedly from element to element. The results so far obtained are of a preliminary character and much detailed work with chemically pure elements will be required to determine the nature and energy of the

ejected particles and of the residual nucleus. It may be that in some elements more than one type of transformation is possible and more than one type of particle is ejected.

Sufficient observations, however, have been made to indicate the importance and power of these new methods of investigating the transmutation of elements. It will be of great interest also to carry the experiments further and to examine the effects produced by swift bombarding particles of different masses, but obviously such experiments will involve much time and labour to carry out over a wide range of elements and over a wide range of voltage. It seems clear, that this new method of attack, so successfully begun by Cockcroft and Walton, will in the course of the next few years give us much new information to help us in throwing light on the structure of nuclei and on the problem of the transmutation of the elements.

Rutherford

THE FOURTH STATE OF MATTER

An appreciation of Sir William Crookes' contributions to modern Physics

By Professor INGO W. D. HACKH,

Author of "A CHEMICAL DICTIONARY," "CHEMICAL RE-ACTIONS AND THEIR EQUATIONS" and "STRUCTURE SYMBOLS OF ORGANIC COMPOUNDS"

Eighteen-hundred-and-sixty was a very interesting and exciting year for young Crookes, twenty-eight years old. Bunsen of Heidelberg had discovered two elements, cesium and rubidium, by a new method and chemistry was undergoing again one of its revolutions of thought. What could be more exciting for a young scientist than try his hand at the new spectroscopic method and hunt down the spectroscopic lines by fixing it to some chemical element. And lo and behold, one of those intense green lines led the young scientist to the discovery of a new element, thallium in 1861. Such great success naturally spurred to further achievement; one element discovered, why not more? It was not long before Crookes began the study of electrical phenomena in gases and the luminescent phenomena connected with it. With an air-pump which he had constructed he reached new high vacua and observed a number of interesting phenomena whenever an electric current was passed through these exhausted glass tubes. At different degrees of the exhaustion different things happened: various glowing areas and dark spaces, waving bands and streamers of light in different colours and at the highest vacuum a greenish yellow uniform fluorescence—enough to set any curiously minded man wondering as to the nature of these glows.

By modifying experimental conditions hundreds of times, patiently observing, recording and comparing, Crookes finally assured the scientific world that the cathode rays are a stream of particles, for they heat up bodies upon which they fall, and that these particles carry negative electricity, for they could be deflected by an electro-magnetic field:—that these particles stream away from the cathode at right angles, for they could be focused by using a convex electrode, and with different velocities, for they are deflected at different angles. Four clear and concise statements of the experimental facts. Now as to their meaning: inasmuch as any gas could be used and the resulting cathode rays were similar in those four respects and differed only in the colour of the glow which gave the spectrum characteristic of the substance, Crookes spoke of a fourth state of matter.

Matter ordinarily solid, liquid or gaseous changed under these experimental conditions into a new and more imponderable state, the highest or finest dispersed, at which each material had its own peculiar colour or characteristic luminosity as revealed by their spectra. This was a striking explanation of the experiments and was promptly ridiculed and attacked on the Continent where the most prominent physicists held the experimental phenomena to be some kind of electromagnetic radiation. However the interesting experimental work of Crookes was the inspiration for Becquerel, the Curies, Roentgen, J. J. Thompson and many others and led to the discovery of radioactive substances, of x-rays, of the electron, and thus to the development of modern physics. I do not wish to trace back to Sir William Crookes all these developments, interesting as that might be, because to no single man can be given credit in a field where thousands are working. I want to discuss, however, the fourth state of matter and how it applies in view of modern concepts.

The term itself has fallen into disuse and many physicists and chemists will smile indulgently whenever a fourth state is mentioned. Change the terminology slightly to comply with the fashion of to-day, call the fourth state of matter to be synonymous with the radiant state of the atom or the excited state of the molecule and Sir William's idea becomes remarkably modern. Does not this fourth state, this radiant state of matter appear whenever we stress and strain matter to the limit of its endurance? We may excite matter, raise its temperature, charge it with electricity, compress and rub it till the sparks fly, explode it or expose it to certain rays and at the end of each of these vigorous treatments there comes a time and condition at which matter gives its distress signal by becoming radiant and luminous—it has transformed some of the incoming energy into its own characteristic light, it is in the last, the fourth state of matter on the boundary or transition between matter and energy, after which follows disruption and disintegration.

How do we explain such phenomena with our present theories of atomic structure? Although the modern physicist demands that ye shall make ye no images or pictures of such things, I believe that any idea which cannot, in one way or another, be fixed by diagram, picture, model or symbol is no physical concept. The picture may not explain the why, but it will show the how.

Let us start with Crookes' experiments and pass an electric discharge through a highly evacuated glass tube. The residual gas in the glass tube is hydrogen and we notice a pale blue glow characteristic of hydrogen. If it had been neon, we would have seen the familiar intense red glow of the advertising signs. What has happened? In our mind's eye we watch an hydrogen atom, it is the simplest type of atom and has a tiny positive nucleus surrounded by a larger negative electron. It is true we might consider a hydrogen molecule, that is two nuclei and two electrons, but in this case there are certain complications which might obscure matters. As soon as the electrodes of our vacuum tube became charged, that is as soon as the slightest potential difference between these electrodes existed, there was set up an electric field and our hydrogen atom responds to it by becoming oriented, the nucleus placing itself toward the negative electrode, the electron toward the positive pole. If the electric field is strong enough, that is sufficient voltage applied, the electron may be pulled out of its orbit, the atom stretches and is now excited, it has absorbed energy. At a certain stage it will snap back again to its original orbit and in doing so will release the energy in the form of light, that is a certain wavelength or coloured flash. Every schoolboy is familiar with the properties of a rubber band which can be stretched between his fingers and used to shoot paperballs at the teacher. In an analogous way the atom has behaved and shot out an impulse of light. If there were but one atom, but one flash would be seen at frequent intervals, for as soon as the atom has returned to normal it

is again stretched and snaps back again and repeats this process over and over as long as the electric current passes through our tube.

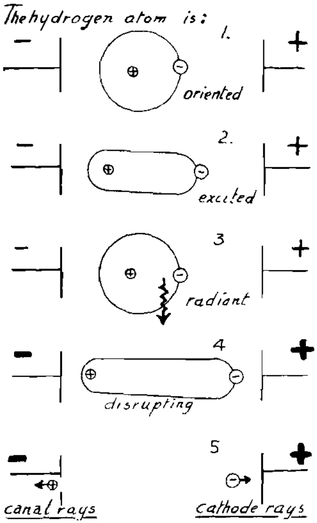


Figure A.

What we see then as the bluish light is the result of millions of little flashes given out by the excited hydrogen atoms returning to normal. We may use direct or alternating current in our experiment and would find that the phenomena depend not only upon the degree of the vacuum in the tube, but also upon the voltage. Should we increase this voltage there will come a time when the atom will be disrupted (Fig. A4) the electrons flying to the anode, the positive nucleus to the cathode. Should this cathode be full of holes, our positive nucleus will pass behind it and thus form the canal rays or positive rays (Fig. A5).

We have seen how light is produced in a Crookes tube, now let us visualize what happens when light strikes matter. When a light wave or quantum approaches an atom (Fig. B1) and is absorbed (Fig. B2) the atom has become excited, that is the electron moves in a higher energy level, and several things may now happen.

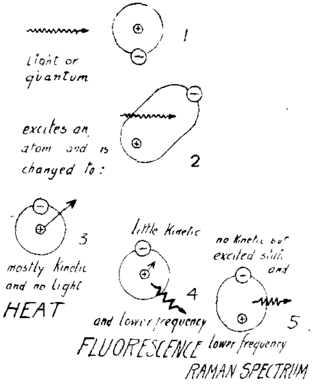


Figure B.

Instead of the nucleus pulling the electron back, the electron may pull on the nucleus and impart to it a certain momentum or speed, the slowly moving nucleus naturally carrying the entire electron system with it. In this case (Fig. B3) the light has been transformed into heat. The other extreme is again like in the Crookes tube, that the electron snaps back to its original state and the atom is luminous. Usually, however, it does not entirely resume its original state, but remains in an intermediate irradiated state and therefore transforms but a part of the incoming light into light of a lower frequency—the lines of the Raman spectrum (Fig. B5). Finally the

energy relations between the incoming light and the exposed atom are such that a little of either extreme happens, namely a small amount of kinetic energy, heat, and light of a somewhat lower frequency is emitted, generally in the visual range, and we say the substance possesses fluorescence (Fig. B4).

We might have puzzled why certain chemical reactions proceed in the light which would not happen in the dark. Thus we have learned in our beginners chemistry that a mixture of hydrogen and chlorine can be kept indefinitely in the dark, but exposed to sunlight will react violently. This phenomenon becomes clear to us now, for we visualize how light increases the size of the atom, and naturally also that of the molecules. Larger molecules travelling at increased speeds will collide more frequently and thus increase enormously the possibility of the molecular reaction.

There are many other and diverse experiments which we can now better understand. Thus selenium is used in photosensitive cells, in the dark selenium is a non-conductor, exposed to light it becomes a conductor. Our explanation of this behaviour becomes simply this: the crystal structure or space lattice of solid selenium is such that in the dark the electron orbits do not touch, hence electrons can not pass from one atom to the other—exposed to light these orbits become excited and the diameter of the atoms therefore increases so that the orbits touch and electrons can travel from one atom to the other and thus conduct a current of electricity.

The photoelectric effect is another interesting phenomenon: We expose the blank surface of a metal to a strong beam of light, the metal becomes positive as negative electrons are given off.

In Figure C we see the diagrammatic eviction of an electron by a light quantum. The incoming light has excited the atom so much that the atom has lost an electron and knocks it away from the surface. Thus we learn that different experimental conditions may cause the transformation of light energy into kinetic energy of the nucleus or heat

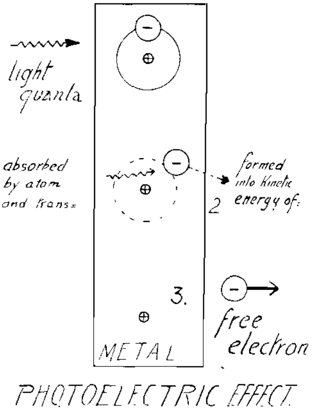


Figure C.

(B3), as well as kinetic energy of the electrons (C3) as in the photoelectric effect, besides the various intermediate states where light of lower frequency is emitted. But we must also realize that only a definite kind of light is being absorbed by a given atom, that each definite wavelength corresponds to a certain transformation of electrons in the atomic system. The spectrum lines tell us of the different energy levels in the atom, while the band spectra give us an insight into the relations within the molecules.

Somewhat similar to the action of light are the effects of cathode rays, which are streams of electrons moving at different velocities. If they are focused upon a metallic target they produce x-rays and heat. The x-rays come from the vibrations or oscillations of the electrons, snapping back and forth within the crystal lattice of the metal serving as target—for the solid state of the metal prevents the larger oscillations of the electrons which would give light of a longer wavelength. The heat and small amount of visible light come from the motion of the nucleus and the atoms on

the surface, some of which are in the gaseous state and may deposit on the walls of the glass tube as the cathodic sputtering or mirror-like deposit. We know now why it is necessary to cool the target and have a large anticathode in order to carry off the electrons from the cathode rays.

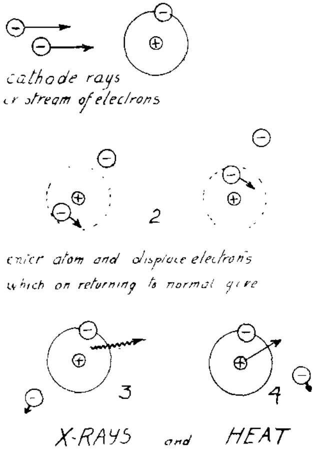


Figure D.

In figure D we visualize what happens to an atom of the metal, here again we have simplified matters by showing but one electron, whereas in fact the metal atom has many electrons surrounding it, but the principle is clear: each incoming electron will disturb the atomic system by setting the electrons in oscillations and causing the short wave radiations (Fig. D3) known as x-rays, or the motion of the nucleus (Fig. D4), that is the high temperature of the target.

The fourth state of matter is the radiant state which appears whenever matter is pushed towards its destruction and the spectral lines and x-rays are the assuring signal that the atom has recovered itself —that the nucleus has again drawn the electrons into its sphere of influence. This state of matter is reached wherever we see a light, be it in the faint glow of a Crookes tube or the brilliant glare of an arc light, the greenish luminescence of distant nebulosities indicating enormous masses of highly diffuse gases far out in space or the shining blaze of the photospheres of sun and stars. In the universe this state is predominant and the prevailing one.

College of Physicians and Surgeons,
San Francisco, Cal., U.S.A.

SIR OLIVER LODGE and CROOKES.

In May last, the Editor of *The Chemical News* wrote to Sir Oliver Lodge for a retrospective article for this issue on Crookes.

The whole of the Scientific world knows of the friendship that existed between these two giants of intellect, and it was therefore considered fitting to ask Sir Oliver for an article. Owing to his prolonged absence on the Continent it was impossible for him to contribute, but the following letter shows how dearly he would have liked to have written.

Normanton House,
Lake,
10*th June,* 1932.

Dear Dr. Blood Ryan.—On my return from abroad I find your letter to-day asking for an article for *The Chemical News*, but it is certainly now too late. I only write to thank you for so vigorously upholding the memory of my old friend the distinguished pioneer, William Crookes.

Yours faithfully,

OLIVER LODGE.

CROOKES' WARNING TO AGRICULTURE AND THE RESPONSE BY THE CHEMICAL INDUSTRY

By SIR HARRY McGOWAN, K.B.E.
(Chairman of Imperial Chemical Industries Ltd.)

Crookes belongs to a type of scientist peculiarly British who is often a puzzle and despair to his continental colleagues. In such men inspiration counts for more than learning and observation more than theorising. Crookes' inspirational gifts were of the highest order. He forecast wireless telegraphy and his views on the composition of matter were in advance of their time. Crookes was no narrow specialist. Once when he was attacked as a specialist of specialists he replied to the effect that he had been the chronicler of general chemistry since 1859, that he had worked on such varied subjects as chemical analysis, disinfection as a cure for the cattle plague, photography, the metallurgy of gold and silver, physical optics dealing with polarised light and the spectroscope, astronomy and meteorology, that he had photographed the moon and been a member of the Government expedition to survey the eclipse. In short, he was anything but a specialist, yet scientific results discovered by him and their implications are now every day practice in any modern research laboratory. For the purposes of the Company of which I have the honour to be Chairman there is one subject of primary importance upon which his views had a great influence. I refer to agriculture.

In his famous address to the British Association in 1898 he laid it down that if mankind did not succeed in finding some method of fixing nitrogen, they would starve. Thanks to the work begun in Germany and carried on by I.C.I., the world can now fix all the nitrogen it needs. What we have to deal with is food production as a result of this. The present state of British agriculture is admittedly lamentable. We have got 5,000,000 acres less under arable crops than in 1868 and half a million fewer people engaged in agriculture.

As I have remarked elsewhere the supposed antithesis of industry and agriculture is a fallacy. If a farmer cannot buy anything, industry cannot sell him anything. This country must have a proper agricultural-industrial balance. It is possible to imagine conditions under which a state is entirely industrial and depends upon the sale of products for its food. Such a condition of affairs in the modern world would be more than dangerous, it would be fatal.

Professor McDougall the famous psychologist remarked about thirty years ago that the greatest danger the world has to face is the increasing growth of national self-consciousness. How right he was is evident to every thinking man to-day.

If we choose to do it we can with the proper scientific use of fertilisers go a long way towards making a much more reasonable balance between agriculture and industry. In considering how we can do this we are much blessed by nature. Charles II remarked that England was a country in which a man could spend more days in the open than anywhere he knew. The fact is that in spite of the way in which we talk about droughts, floods, heat waves, etc., England has first-class arable land and the finest grass pasture in the world, and there is nothing to stop us making more use of it. Within reason it is wise not to be too much alarmed about present prices, the psychological side must be considered. It is better to be working and to be happy than to be living on the dole, and the history of the world shows that in course of time working costs adjust themselves to selling prices.

My Company has been working on the scientific side of agriculture for some years. In a book recently published by Sir Frederick Keeble proof is given that if artificial fertilisers were applied in this country on a scale comparable with that of Holland, we could raise the cereal production of the country by 19%, we could increase our potatoes by 18%, our sugar beet by 23%, mixed root crops by 7% and hay by 41%.

Crookes exposed a danger. Under the stimulus of his warning we have averted it though we now face another danger—the

lack of co-ordination between consumption and production. The solution of this problem depends no longer on the chemist or on the producer, but upon the co-operation of the Empire in marketing distribution and finance.

SIR WILLIAM CROOKES

By Professor NICHOLAS KNIGHT

Author of "QUANTITATIVE CHEMICAL ANALYSIS," "BLOW PIPE ANALYSIS" and "CHEMISTRY OF COLLOIDS"

Sir William Crookes was one of the greatest men whom it has ever been my good fortune to have known. He excelled in his broad general knowledge, in the realm of science, and he was kind and sympathetic in all human relationships.

I remember, when visiting him in his beautiful London home, in the summer of 1912, he seemed to take an especial pride in showing me his physics and chemistry laboratories, and his workshop where he made some of the apparatus with which he accomplished so much in the realm of pure science.

I found that it was his practice to labour sixteen to eighteen hours a day At this time, as I remember, he was at work on the spectrum of scandium. I was deeply impressed by the fact that here was a great man, working long hours in the privacy of his laboratory, without material compensation, but solely for the love of accomplishment.

I congratulated him on his successful life and notable achievements, but he modestly replied, "When I think of what I might have done and really have accomplished, I feel very small and undeserving of much praise." The world returns a different verdict. He showed me an iridium crucible of the usual size, explaining that it was more satisfactory and efficient than platinum.

Among the photographs which I highly prize and have had framed is one commemorating his golden wedding anniversary, dated April 10, 1906. Another is Sir William in the D.Sc. robes of the University of Birmingham. In a letter dated January 4, 1916, he explained that it is a real coloured photograph and not hand painted.

Another is the photograph of the oil painting of Sir William in the rooms of the Royal Society. A letter accompanied the picture :—

7, Kensington Park Gardens,
London, W.
May 8, 1911.

My dear Professor Knight,

I have been away from home for some time owing to my wife's illness. We have been to a quiet place by the sea and I am glad to say the change has done us both good.

You are very kind in congratulating me on the honours coming to me. Allow me to ask your acceptance of a copy of the portrait which was presented to the Royal Society. It is considered by all my friends to be a very good likeness.

With kindest regards,
Believe me,
Very Sincerely Yours,
WILLIAM CROOKES.

The following is another letter received during the World War, with comments by our local editor. This is printed in the *Chemical News* in the issue of March 24, 1916.

"A personal testimony of the gloom and distress war creates was brought home to local circles this week in a communication from Sir William Crookes, the eminent English chemical authority, to Dr. Nicholas Knight, of Cornell College. A letter written from London and received this morning contains the following significant and impelling expressions :—'Everything at this Christmas time here is very depressed, and the weather is gloomy and sunless. The cruel losses in the war are causing grief to most families, and the heavy taxation necessary is crippling the means of all families. If the murderous piracy on the high seas continues we are hoping that your powerful country will render us substantial assistance in putting a stop to it for the sake of humanity at large.'

In a private letter to Sir W. Crookes, Professor N. Knight writes :—"I have forwarded a copy of your letter to President Wilson. I trust it will catch his attention and have weight in shaping the Nation's policy in respect to the German submarine warfare."

Soon after this, President Woodrow Wilson began sending those strong letters of protest, in regard to the submarine warfare to Emperor William. It would therefore seem that Sir William Crookes had an important part in the entry of the United States into the World War.

Nicholas Knight.

Department of Chemistry,
Cornell College,
Iowa, U.S.A.

CROOKES, AND HIS FAITH

By HENRY T. F. RHODES

Hon. Editor of *The Chemical Practitioner* and one-time General Secretary, British Association of Chemists.
Author of "GENIUS & CRIMINAL" and "SOME PERSONS UNKNOWN."

There is a sense, and it is in the best sense, that Crookes was in the tradition of the alchemists. The opinion, once so fashionable, that the word alchemist is but a synonym for charlatan, or worse, is no longer so popular. It is now recognised that their theories, however fantastic they may appear, were a perfectly consistent expression of a philosophy about which there is nothing inherently absurd. It is quite true that alchemy had not a mathematical basis; but it is also true on the other hand that modern science has no philosophy. Perhaps what has been gained on the swings has been lost on the roundabouts.

Crookes very definitely had a philosophy. His "fourth state of matter" was, besides being a scientific theory, an affirmation of faith. This was quite in the tradition of the alchemists whose theories as to the nature of matter rested upon a like premise. The modern electronic theory of matter has shown that however dubious the method of arriving at it, the conclusion itself was not far wrong.

Like the alchemist, Crookes was also preoccupied with the practical aspect of truth. Like Aristotle he would have held that there was no truth that was a truth for nothing. It is sometimes forgotten of the alchemists that the object of their experiments was to establish the truth of their theories. In a word they were the pioneers of scientific method, however crude their actual methods may have been. And in their search they discovered many things of great practical importance.

Crookes' mind had a strong practical bias. He was always eager to investigate discoveries of practical importance to mankind. His work in connection with the production of synthetic gems is a case in point. Artificial diamonds are commonly associated with the name of Moissan who was certainly among the first to draw attention to the subject; but it was Crookes who initiated a method of treating carbon which could in any sense be called practical. He read a paper before the Royal Society describing his experiments and results in 1906. By exploding cordite in a heavy steel tube he discovered that under suitable conditions pressures up to fifty tons per square inch could be obtained, and temperatures of the order of 5,400 degs. By this means he liquified carbon which was recrystallized in the form of diamond. Crookes actually obtained very small, but not microscopic diamonds, as other investigators had done, by this method. They measured in some cases half a millimetre across.

But the Emmens affair of 1897 is most oddly reminiscent of alchemy, although it was alchemy with a difference. Dr. Emmens held, or affected to hold, formal alchemical theories which he very ingeniously and ably endeavoured to bring into line with modern views. He either accepted Crookes' "fourth state of matter," or held some similar view as to the ultimate nature of matter.

It was his Argentaurum Theory which brought him into correspondence with Crookes. Emmens claimed that by a special process of hammering silver, the

silver could be converted into gold. In a paper on the subject he had observed that gold was always found in association with silver. Emmens accounted for this fact by a theory that gold and silver had a common origin which he called argentaurum, an intermediate metal. Silver could, through argentaurum, be converted into gold, or conversely gold into silver. The paper was ably and temperately written. The apparatus he employed was one that hammered the metal continuously under conditions which allowed the heat produced to be conducted away rapidly. He had a laboratory where he claimed that gold was produced in this way, and sold to the United States Government. Whatever its origin, it is certainly a fact that he did sell gold to the American Mint.

He requested Crookes to test his process, and an apparatus was constructed for this purpose. It consisted of an iron receptacle with a close fitting iron piston weighing about twenty-eight pounds which delivered sixty blows a minute. This was immersed in another vessel with coils through which liquid carbon dioxide was passed to keep the whole at a low temperature. According to Emmen's instructions a Mexican dollar of known gold content was hammered in this apparatus. The results, curiously enough, seem not to have been absolutely negative. The gold found before was equivalent to 0.062 per cent., after hammering, it was found to be 0.075 per cent. This was regarded by Crookes as inconclusive, and the more so since a repeat experiment with chemically pure silver gave negative results.

Emmens retorted that the first experiment was not negative and that, as to the second, it was necessary for success that the silver should contain a trace of gold or no result could be obtained. Crookes, however, satisfied with his tests, did not follow the matter up.

But the fact that he performed the experiments at all is proof of the liberality of his mind. The theory, as he saw it, if not very probable, was not absurd. He was prepared to put it to the test of experiment. It is interesting to speculate as to how far his theory as to the ultimate nature of matter—and its points of contact with Emmen's alchemical theories—may have influenced him to put this Argentaurum Theory to the test.

Crookes' mind, nevertheless, had no credulously alchemical turn. The great monument of his life and work is witness to that.

BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION.

The Annual Meeting of the Association was held at the Savoy Hotel, London, on June 7th, when addresses were given by Sir Auckland Geddes, Sir Frank Smith, F.R.S., and Mr. Thos. Bolton. The report of the year's work issued on this occasion gives details of the extensive Programme of Research, the progress of the Development Section, which aims at stimulating industrial application of the results of research, and the Information Services provided for members.

The scale of the Association's work has grown considerably in recent years and its income now exceeds £25,000.

Both the report and the speeches at the Annual Meeting clearly indicate the value of the Association's work to its members and to the progress of the metal industries, for tangible results of direct commercial application are now being secured to a rapidly growing extent. The Association appeals for a larger membership and greater financial support, particularly from those who stand most to benefit by utilising the improved construction materials which are resulting from its work.

Apart from its 23 major researches, which cover such practical subjects as the Frost Bursting of Water Pipes, the Tarnishing of Metals used for shop fronts, the Effect on Health of Aluminium Cooking Vessels and the Corrosion of galvanised hot water Tanks, the Association's Staff affords service to its members in a wide variety of directions, which is appreciated both by those who have their own Research Departments and by those who rely on the Association as the main source of scientific advice.

METALS RESEARCH FOR INDUSTRY.

The 12th Annual Report of the British Non-Ferrous Metals Research Association has just been issued. It is encouraging to note that despite the intense industrial depression this Association has received in subscriptions from its members a larger sum than in any previous year. The total income, with Government Grant, is over £25,000 and a very extensive programme of work is being carried out.

The new headquarters in London has during the past year been brought into full use and contains a model Information Bureau, Research Laboratories and the Development Section with its exhibition of some of the Association's research results, which serves as a stimulus to the application of the research results by industry.

The growth of the Association in recent years has been remarkable, but from the report it is obvious that great difficulties are still met with in financing the research and other work which has been planned. Considering the large extent of the field of industry which is covered by this Association, the present membership of 200 is much too limited.

The tangible results which can be shown have been of great benefit to the engineering industries, but those who ultimately benefit as users of metals apparently provide very little financial support to the Association, the subscriptions coming mostly from the metal manufacturers themselves.

A section of the report deals with the future outlook and claims that even greater success would promptly accrue from the more intensive co-operation of existing members and from a moderate and steady increase in the funds available to the Association. Amongst new materials which have been made available to industry by the Association's researches, the elastic "Stayput" copper for locomotive fireboxes, the new ternary alloys for cable sheathing and water pipes and the aluminium brass condenser tubes, are of outstanding importance.

The practical nature of the Association's work is indicated by the researches it has in hand on such subjects as the Frost Bursting of Water Pipes, the Effect on Health of the use of Aluminium Cooking Vessels, Bearing Metals, the Tarnishing of Metals used for shop fronts, etc., and last but not least the searching enquiries which it is undertaking for its members on the improvement of the efficiency of industrial production.

The report deserves the attention of all concerned with the production and utilisation of metals and can be obtained from the Association's Headquarters, Regnart Buildings, Euston St., N.W. 1.

Notices of Books.

Chemical Encyclopædia, by C. T. KINGZETT, F.I.C., F.C.S. 5th Edition, 1932. Pp. 1,014. Price 40s., London. Balliére, Tindall & Cox, 7 8, Henrietta Street, W.C. 2.

This work really requires no notice to those of us intimately connected with chemistry and its industrial application, unless it is considered in the light of its completely revised condition. The author also needs no introduction, especially to readers of the *Chemical News* as he has been a contributor to its pages, more particularly during the regime of Crookes. Mr. Kingzett is to be regarded as one of the fathers of our modern Chemistry, being one of the Founders of the Institute and a sponsor of *The House of Chemistry*, which latter has yet to materialize. Kingzett is a patriot first and a chemist second, striving during the whole of his life for the achievement of a supremacy (now about to materialize) in matters Chemical of the British Empire.

Considered in the light of his early task, the piecing together of Chemical information and Knowledge has now assumed gigantic proportions and when we consider that he has added 200 pages to the text of the previous Edition, and introduced many new subjects, we can judge the meticulous care he has bestowed upon his monumental work. I find the work up-to-date and this is a feat if we consider the improvements being made from time to time, while a work of this nature is in the press. In the preparation of the present work Mr. Kingzett has received the help of *inter alia*, Prof. G. T. Morgan, Prof. H. T. S. Britton, and Dr. O. Rosenheim, so this help in itself adds to the lustre of the work.

The volume should be in the possession of all Manufacturers, Lawyers, Brokers, Merchants, Medical Practitioners, Pharmacists and Chemists and should also prove a valuable aid to students.

The reviewer feels that this work can be unqualifiedly recommended to all interested in Chemistry and its industrial application.

THE CHEMICAL NEWS

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Edited by H. W. BLOOD RYAN, M.A., D.Sc., LL.D., Ph.D.

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MICHAEL FARADAY & ELECTRO-CHEMISTRY*

By Brig.-General Sir HAROLD HARTLEY, C.B.E., M.C., M.A., F.R.S.

Director of Scientific Research, London, Midland and Scottish Railway Company; Research Fellow of Balliol College, Oxford.

There is no need to remind you of the close association of the Royal Institution with the early history of electro-chemistry, for it must be amongst your proudest memories. In this building Davy carried out his investigations of the chemical effects produced by an electric current, which culminated in the isolation of the metals sodium and potassium in 1807, one of the most dramatic discoveries in the history of Chemistry. Twenty-five years later it was here, too, that Faraday established the fundamental laws of electrolysis by the researches which are the subject of my discourse this evening.

I am not going to speak to you so much of the results of Faraday's discoveries, but rather to trace the way in which those discoveries were made, with the aid of the pages of his diary. Faraday's diary is a unique scientific and human document, in which he recorded in numbered paragraphs, which ran to 16,041, not only the results of his experiments, but the ideas that flashed on him as he was working in the laboratory, and his plans for new researches. By means of it we can follow his progress from day to day, and watch the interplay of ideas and experiments, and the swiftness and certainty with which he reached a decision.

When Faraday was still a bookbinder's apprentice, his eager curiosity was excited by the discoveries of Davy, and he made experiments on the electrolysis of solutions with home-made batteries, consisting of discs of zinc and half-pennies, when half-pennies cannot have been too plentiful with him. In 1813, at the age of twenty-two, he came to the Royal Institution to be Davy's assistant. You know the romantic story—how

* Lecture delivered before Royal Institution on Friday, March 4th, 1932.

Faraday was brought to hear Davy's last lectures in this theatre, and made detailed notes which he bound and sent to Davy for correction, and how Davy was so much impressed by them that he invited Faraday to be his assistant when a fortunate vacancy occurred. I often marvel at that slender chain of events which was destined to mean so much to the progress of science.

Faraday served his apprenticeship to Chemistry under Davy in this building. He soon began to carry out investigations himself, and from 1816 onwards a constant stream of papers appeared under his name. They form no connected series, and there was no general idea underlying them, but they ranged over the whole field of chemistry—physical, inorganic, and organic. The papers reveal Faraday's skill as a practical chemist, the neatness and simplicity of his experimental methods, and the quickness and accuracy of his observations. They are mainly records of experiments, as, owing to Faraday's scepticism regarding the atomic theory, probably acquired from Davy and Wollaston, he seems to have taken little interest in the problem of the atomic constitution of substances which was just beginning to perplex chemists. When he discovered naphthalene-sulphonic acid, he called it "sulpho-naphthalic acid, which," he said, "sufficiently indicates its source and nature without the inconvenience of involving theoretical views." But in those years Faraday was gaining the first-hand acquaintance with the properties of many substances, which was to prove invaluable to him in choosing the right materials for his experiments. He was also accumulating an unrivalled knowledge of chemical technique, and gaining the confidence and certainty to which was due the boldness and directness of his experiments in the years to come. In 1827 he published his book on "Chemical Manipulation," in which he describes every kind of laboratory operation and device. It is one of the most personal documents in scientific literature, as every page is a record of his own experimental methods, and it reveals how every detail of each operation had been studied by him and reduced to its simplest and most effective form.

The year 1831 was the turning-point in Faraday's career. There is no greater contrast in scientific literature than his earlier chemical papers characterised by their essentially practical outlook and accomplishment, and the brilliant flights of imagination that inspired his "Experimental Researches in Electricity."

Many reasons have been given to account for this sudden transformation—that Faraday's powers were maturing gradually in readiness for that great outburst of intellectual activity in his fortieth year—that he had fallen in love; but we know that Faraday fell in love in 1820, and remained in love all his life: besides, I have never observed that that particular form of preoccupation has been prolific in scientific discoveries—that Faraday had been elected to the Royal Society: but that happened in 1824—that he had been released from the tutelage of Davy: but he was made Director of the Royal Institution laboratory in 1825, when he instituted these Friday evening discourses.

No. I am convinced that it was the discovery of electromagnetic induction, the success of an experiment which Faraday had previously tried again and again without result, that gave the new impulse to his work and gave him confidence in the promptings of his imagination. What are the facts?

Electricity was one of Faraday's earliest scientific interests. Long before he went to Davy he was experimenting with home-made batteries. Already in 1816 we get a glimpse of his intuitive belief in the essential unity of the forces of nature, which was to influence so greatly the current of his researches. His first lecture to the City Philosophical Society was on the general properties of matter, and we find him speculating on the forces underlying material behaviour and on their inter-relation. "That the attraction of aggregation and chemical affinity is actually the same as the attraction of gravitation and electrical attraction I will not positively affirm, but I believe they are." In 1821, Faraday repeated the experiments of Oersted,

Arago, and Ampère on electro-magnetism and discovered the rotation of a wire carrying a current if free to move round a magnetic pole. Magnetism had been produced from electricity, and Faraday was convinced of the possibility of obtaining electricity from magnetism. In 1824 he was experimenting with a magnet in a helix connected with a galvanometer, without result, and similar experiments were made in 1825 and 1828. Either the galvanometer was too insensitive or he failed to notice the momentary deflection when the magnet was introduced. On August 29th, 1831, the induced current was detected—Faraday's dream had come true—and ten days of decisive experiment ended in his paper on "The Induction of Electric Currents," which was to shape the future of electrical industry.

It is significant of Faraday's train of thought that the first experiment he made on August 29th, 1831, after discovering the induced current, was to attach platinum wires to the ends of the coil and see if he could detect any decomposition in a drop of copper sulphate solution. The test was not delicate enough, and he did not succeed in detecting the chemical power of magneto-electricity until several years later. However, he made a number of experiments on chemical means of detecting the current from a voltaic cell, and on June 11th, 1832, he found in bibulous paper moistened with potassium iodide and starch the most sensitive detector.

His discovery of electro-magnetic induction raised afresh in Faraday's mind the old and still disputed problem of the identity of electricities from different sources, and chemical action was one of the tests he applied to its solution. Having shown that common (frictional) voltaic and magneto-electricity all produce similar physiological, magnetic, chemical, and thermal effects, Faraday sought to establish their identity by quantitative experiments. Among the discoveries that Cavendish had made almost fifty years previously, was that the behaviour of an electric charge depends on two factors, the degree of electrification (or potential as we should call it) and the size of the charge. His paper on the torpedo, published in 1776, contains an account of experiments with Leyden jars which demonstrate very clearly this distinction. Faraday had read Cavendish's paper and realised that his theory explained the apparent differences in behaviour of frictional and voltaic electricity. He says: "The beautiful explication of these variations afforded by Cavendish's theory of quantity and intensity requires no support at present, as it is not supposed to be doubted."* The theory was, however, by no means generally accepted in 1832, but Faraday's recognition of its truth was the key to the success of his researches on electro-chemistry.

He started out to prove that the effect on a galvanometer of a discharge of frictional electricity was dependent on its quantity and not on its intensity, which he showed on September 14th, 1832, by charging 8 Leyden jars in a battery of 15 by means of 30 turns of a frictional machine, and seeing that when discharged through the galvanometer they caused the same throw of the needle as the whole 15 jars charged by means of 30 turns, although an electrometer indicated that the intensity of the charge was roughly one-half in the second case. "Hence," said Faraday, "It would seem that if the same absolute quantity of electricity passed through the instrument whatever may be its intensity, the deflecting force is the same."

He then made a small "standard elementary battery," consisting of platinum and zinc wires $\frac{1}{8}$th inch in diameter, and $\frac{5}{16}$th of an inch apart, which he immersed to a depth of $\frac{5}{8}$th inches in dilute sulphuric acid (one drop of acid in 4 oz. water), and he found that by immersing the wires for 8 beats of his watch (3.2 secs.) when they were joined to a galvanometer, the momentary deflection of the needle (its half period of swing was 6.8 secs.) was the same as that caused by 30 turns of the machine. Hence, said Faraday, the amount of electricity pro-

* "Experimental Researches," Vol. I, p. 81 (1833).

duced by the cell in this time was the same as that produced by 30 turns of the machine. He next compared the amounts of chemical change by allowing the electricity to pass in both cases through filter paper moistened with potassium iodide on a platinum spatula with a platinium wire th inch in diameter as the positive pole. A brown circle of iodine was found at the point of contact and its tint depended on the number of turns of the machine. Faraday showed by varying the number of turns of the machine that it required approximately 30 turns to produce an iodine spot of the same tint as that given by immersing his standard battery for 8 beats of his watch. "Hence it would appear that both in magnetic deflection and in chemical effect the current of the standard voltaic battery for 8 beats of the watch was equal to the electricity of 30 turns of the machine, and that therefore common and voltaic electricity are alike in all respects."

I have described the experiments made on September 14th and 15th, 1832, in detail, as they were the first attempt to connect the quantity of electricity passing in an electric current with the amount of chemical decomposition accompanying it, and there is no better example of the neatness, the simplicity, the directness, and the conclusiveness of Faraday's experimental methods. When everything was ready for the attack, two days sufficed to reveal to Faraday the fundamental relation which was to shape the course of his future work. The paper on "The Identities of Electricities" was not published until December 10th, an unusually long delay for Faraday; but in the interval he did no more experiments, and the paper contained the first statement of his First Law of Electrolysis: "It also follows that for this case of electro-chemical decomposition, and it is proved for all cases, that the *chemical power, like the magnetic force, is in direct proportion to the absolute quantity of electricity* which passes."

Faraday's actual researches on electrochemistry occupied the next eighteen months of his life. The three main problems with which they deal are:—

1. The mechanism of condition in solution and the dependence of the passage of the current on chemical decomposition.
2. The amount of chemical action accompanying the passage of the current.
3. The source and the intensity of the current produced by voltaic cells.

Owing to Faraday's association with Davy the problem of conduction in solutions was not new to him, and a sentence in his letter to Richard Phillips on November 29th, 1831, describing his discovery of electro-magnetic induction, shows his interest in it: "I believe it will explain perfectly the *transference of elements* between the poles of the pile in decomposition."

The main experimental facts had been known to Faraday since the days when he experimented with a home-made battery while he was still a bookbinder's apprentice. Pure water would not conduct a current, but the addition of acids or salts made it a good conductor, and at the same time decomposition occurred, the products being liberated not in the body of the solution, but at the surface of the metallic conductors, which were called the poles. The word "pole," from its association with the magnet, suggested the idea that the decomposition was due to attraction or repulsion caused by the poles. With most acids and bases, and also with a number of salts, the products were hydrogen at one pole and oxygen at the other. In the presence of certain salts, such as copper sulphate and lead acetate, the metal was deposited at the negative pole instead of hydrogen. In the case of salts such as sodium sulphate, acid was liberated at the positive pole and alkali at the negative.

In trying to find the most delicate test for the passage of electricity, Faraday made many new experiments on the chemical action produced by a current. In one of them he placed one end of a long piece of litmus paper moistened with sodium sulphate in contact with an electrical machine, while the other end was held opposite to the discharging points. On turning the machine Faraday

saw that decomposition took place, the paper becoming red "where the positive electricity entered from the air. This proved to him that the decomposition was not dependent on the presence of metallic poles in the solution, and on September 6th he wrote in his note-book: "Hence it would seem that it is not a mere repulsion of the alkali and attraction of the acid by the positive pole, etc., etc., but that as the current of electricity passes whether by metallic poles or not the elementary particles arrange themselves and that the alkali goes as far as it can with the current in one direction and the acid in the other. The metallic poles used appear to be mere terminations of the decomposable substance.

"The effects of decomposition would seem rather to depend upon a relief of the chemical affinity in one direction and an exaltation of it on the other rather than to direct attraction and repulsions of the poles." Here we see the germ of Faraday's ideas on the nature of electrolysis.

In October and November 1833, only two days were spent on electrical experiments, but Faraday was constantly thinking of the mechanism of conduction in a solution, and suddenly on December 24th he wrote: 'Can an electric current, voltaic or not, decompose a solid body, ice, etc., etc.? If it can does it give structure at the time? If it cannot what would fused gum, lac, wax, etc.?" A cold spell at the end of January enabled him to put this to the test, and he found that while ice would not conduct a voltaic current, conduction occurred immediately the ice melted. "If ice will not conduct is it because it cannot decompose?"

It was characteristic of Faraday's thoroughness that he went on to examine the conductivity in the fused state of a number of substances which are solid at ordinary temperatures, and to study the products formed during electrolysis. It was a new field for him and he showed his usual experimental skill in devising simple methods for working at high temperatures, including even the use of the oxyhydrogen blowpipe. During February and April he examined over 130 substances and found that while a number resembled water in being insulators in the solid state and becoming good conductors if fused, when they were decomposed by the current, certain of them, such as boric acid, did not conduct when fused. He thus arrived at no general conclusion, but the experience he gained in working with fused salts was to prove invaluable later in the year in his work on electro-chemical equivalents. The experiments were finished on April 22nd, and on April 24th they were communicated to the Royal Society with the title, "On a New Law of Electric Conduction."

Faraday then turned his attention to the mechanism of conduction in a solution. On May 2nd he passes a strong current through a saturated solution of sodium sulphate and examines it with polarized light both across and along the direction of the current to see if he can detect signs of arrangement of the molecules, but without result. On May 20th he determines the transfer of sulphuric acid during electrolysis by measuring the changes in concentration in two vessels connected by moist asbestos, and on May 27th he shows that the transfer of sulphuric acid differs from that of sodium sulphate of equivalent concentration, "very evident therefore that the transfer is dependent on the mutual action of the particles." He summed up his views in a paper to the Royal Society on June 18th, the main conclusion being "that electrochemical decomposition does not depend on the simultaneous action of two metallic poles," and the effects of it "are due to a modification, by the electric current, of the chemical affinity of the particles through or by which that current is passing, giving them the power of acting more forcibly in one direction than in another, and consequently making them travel by a series of successive decompositions and recompositions in opposite directions, and finally causing their expulsion or exclusion at the boundaries of the body under decomposition."

In May 1833 Faraday's thoughts were returning to the question of the amount

of chemical action that takes place during the passage of a current. On May 16th no experiments were recorded in the note-book, but among the ideas he jotted down was: "Is the law this (above a certain intensity *i.e.,* the one required for decomposition to take place at all), that whatever the size of plates, or number intervening, or constant section of decomposing matter, or variable section, or variable strength, or number of series in the battery: that . . . equal currents of electricity measured by the galvanometer evolve equal volumes of gas or effect equal chemical action in a constant medium?" A week later he writes down his plans for testing the law: "By putting cups and expts. in succession and sending the electrical current through both or all am sure that each is submitted to an equal force. Can try well this way whether the same quantity or different intensity does the same chemical work using same dilute sulphuric acid but *different-sized poles,* and collecting gas, and that will tell—some poles mere wires, others large plates." Three months elapsed before he actually carried out the experiment. On August 27th he wrote: "Pursue the investigation, whether the *same quantity* of electricity *always* produces an equivalent of chemical decomposition. . . ." On August 30th he found, as he expected, that the same amount of current liberated the same volume of gas irrespective of the concentration of the acid, the size of the electrodes, or the intensity of the current. He obtained the same results with solutions of various salts, and his comment was: "Strange that with such different substances the same quantity of water should be decomposed by the same current." These experiments were continued in September, and Faraday was constantly puzzling over the effect of various substances in increasing the conducting power of water. On September 17th he showed that cells containing muriatic and sulphuric acids had given the same volume of hydrogen when connected in series, and he was now busy constructing a simple apparatus to measure the quantity of electricity by means of the volume of gas produced by it. "The instrument offers the only *actual measurer* of voltaic electricity which we at present possess . . . I have therefore named it a volta-electrometer."* To-day, following Faraday, we define our practical unit of current by its electrolytic action, and we use his name to denote the fundamental unit of electro-chemistry.

On September 19th, among his observations, he notes: "Will not white-hot diamond conduct? If so may perhaps crystallise carbon at white heat by power of the voltaic battery."

He had been worried by the contraction, on standing, of the mixture of oxygen and hydrogen obtained in the electrolysis of sulphuric acid. He traced this to the catalytic activity of the platinum electrode, and showed that the positive and not the negative was effective. This observation led him to spend some weeks investigating the conditions under which platinum and other metals would assist the combination of various gases, when he discovered the retarding effects caused by small quantities of gases such as olefiant gas, carbonic oxide, and sulphuretted hydrogen. The results were communicated to the Royal Society on November 30th.

Faraday then returned to the investigation of the amount of chemical action produced by the current, and as he recognised that in the electrolysis of aqueous solutions it was doubtful whether the elements liberated at the poles were to be regarded as primary or secondary products, he extended the inquiry to include fused substances, which would be free from this ambiguity.

Hitherto Faraday had only compared the quantities of the same substance, such as hydrogen liberated by the same current in a series of cells, but he now began to consider the relative quantities of different elements that would be liberated by the same current. On September 23rd he wrote: "Think it will be very important to have a new relation of bodies, under the term *electro-chemical equivalents,* tabulated. Very important as to decomposing powers of the pile, as to the

* The name was contracted to voltameter five years later.

true expression of equivalent numbers, and as to nature of chemical affinity and its relation to electrical states and powers."

On September 28th in discussing the results of experiments in which a current is passed through a sulphuric acid voltameter, and various solutions in series with it, Faraday decided that in aqueous solution the current is probably carried by hydrogen and oxygen, these being always the primary products of electrolysis. "When, therefore, metallic solutions are decomposed the metals are evolved not by the current of electricity but by the hydrogen evolved at the N. Pole . . . . Hence it will probably follow that in these cases the metal is an equivalent of the hydrogen because it is produced chemically by the hydrogen, and therefore such effects *will not prove* the equivalent character of the products of true electro-chemical decomposition . . . . Perhaps fused nitre will be a good salt to compare by current with decomposition of water. Or fused chloride of lead or tin." These experiments with fused salts, which removed any doubt as to whether the elements liberated during electrolysis were primary or secondary products, were not carried out until December, but doubtless in the interval Faraday was making plans for them.

On December 17th he wrote in his notebook: "Proceeded to decompose dry chlorides, oxides, etc., to ascertain if there also the decomposition was definite and what the equivalent numbers would be." So quickly was the final stage in the investigation accomplished that on January 9th, 1834, the paper containing the Laws of Electrolysis was communicated to the Royal Society. In the first experiment on December 17th fused stannous chloride in a glass tube was decomposed with platinum wire poles with a voltameter in series, and the weight of the tin liberated compared with the weight of water (0.26486 grain) decomposed in the voltameter. "1.76 of tin had been electro-chemically evolved at the exode, and of course a corresponding portion of chlorine at the cisode.

W T
Now 0.26486 : 1.76 : : 9 : 59.805 the tin.

The number for tin is given 58 which is very near indeed for a first experiment, and shows that the electro-chemical equivalent is the same as the chemical equivalent here." Note Faraday's first efforts at a new terminology, "exode" and "cisode." Later on the same day the word "pole," which suggests the idea of attraction or repulsion, was struck out and "electrode" written above it for the first time.

On the following day another experiment with stannous chloride gave a value of 53.833 for tin. Two similar experiments with fused lead chloride gave electro-chemical equivalents for lead of 105.11 and 97.22, the chemical equivalent being 103.5 or 104.

Faraday wrote of the lower value: "Hence it is too little, but still so near as to establish the principle of electrochem equivalents."

On December 19th no experiments are recorded, but doubtless Sergt. Anderson was helping Faraday to set up apparatus, and fresh glass vessels with fused-in electrodes had to be blown for each experiment. A few extracts from the note-book on that day show the activity and range of Faraday's mind:—

1192. "With regard to *intensity* and its meaning, etc. Define intensity if possible and state its relation to *quantity, time and conducting power.*"

1195-1200. "Nervous agency of Electricity."

1207. "In the table I mean Real Electro chemical equivalents not hypothetical for we shall else outrun fact and lose the information directly before us. . . . I must keep my researches really *Experimental* and not let them deserve anywhere the character of *hypothetical imaginations.*"

1212. "Search for Fluorine by using a plumbago Pos. Pole acting on a fluoride."

1213. "This process may finally give rise to some very good processes of analysis in determining weights or at least to some excellent modes of comparing weights of metals . . . *a good principle of analysis* for it will hold probably in salts as well if properly selected and may use mercury electrodes when convenient."

A remarkable anticipation of modern methods of electrolytic analysis.

With the exception of Christmas Day, determinations were made every day. On December 26th Faraday comments in his diary on the enormous quantity of electricity required to decompose a small

amount of water. Later he estimates that 800,000 charges of a Leyden battery, each one of which would suffice to kill a cat, "would be necessary to supply electricity sufficient to decompose a single grain of water; or, if I am right, to equal the quantity of electricity which is naturally associated with that grain of water, endowing them with their mutual chemical affinity!"

The experiments on the electrolysis of fused salts were difficult and often gave inconclusive results, but confirmatory evidence was obtained from lead borate and iodide.

Faraday was anxious to extend the work to the deposition of metals from aqueous solutions, and he found that zinc deposited on a platinum electrode gave an electro-chemical equivalent of 34.08, while the loss in weight of amalgamated zinc in contact with platinum compared with the weight of hydrogen evolved gave in two experiments equivalents of 30.2 and 32.31. "Excellent," he writes after the latter result, to which he attached great importance, as it was the first occasion on which he had compared the amount of chemical action in a voltaic cell with that produced by the current in the external circuit. This confirmed his conviction "that the quantity of electricity which, being naturally associated with the particles of matter, gives them their combining power, is able, when thrown into a current, to separate those particles from their state of combination; or, in other words, that the electricity which decomposes, and that which is evolved by the decomposition of a certain amount of matter, are alike.

"The harmony which this theory of the definite evolution and the equivalent definite action of electricity introduces into the associated theories of definite proportions and electro-chemical affinity is very great. According to it, the equivalent weights of bodies are simply those quantities of them which contain equal quantities of electricity . . . . it being the ELECTRICITY which determines the equivalent number, because it determines the combining force. Or if we adopt the atomic theory or phraseology then the atoms of bodies . . . . have equal quantities of electricity naturally associated with them. But I must confess I am jealous of the term atom, for though it is very easy to talk of atoms, it is very difficult to form a clear idea of their nature."

These sentences must have been written immediately after the experiments were made, as the paper was communicated to the Royal Society on the same day (January 9th). During these three weeks Faraday worked at very high pressure, and it was no wonder that on January 7th he wrote: "I wish I could evolve *time* from the battery as well as all these points *and then* . . . . " He was true to his maxim: "Work. Finish. Publish."

The paper itself is the most important of Faraday's contributions to electro-chemistry, and in it he summarises all his previous work. He begins by introducing the new terminology which he devised with the help of Whewell for the sake of greater precision of expression, and all his new names—electrode, anode, cathode, ion, anion, and cation, electrolyte and electrolysis—we use to-day with the significance which Faraday gave to them. After a short account of the conditions necessary for electro-chemical decomposition, he describes his new volta-electrometer and the evidence that led him to the conclusion that the amount of chemical action is dependent solely on the amount of electricity that passes through it. He next discusses whether the products of electrolysis are primary or secondary, and gives his evidence for the identity of chemical and electro-chemical equivalents.

The researches had strengthened enormously the evidence for his First Law of Electrolysis—"The Chemical power of a current of electricity is in direct proportion to the absolute quantity of electricity which passes"; and they had established the Second Law—"Electro-chemical equivalents coincide, and are the same with ordinary chemical equivalents."

The exactness of these two laws has been confirmed by every subsequent investigation.

For three weeks he tried to isolate fluorine, and on February 10th thought he had obtained it by the electrolysis of fused lead fluoride. "Must now lay this subject aside for a while and go to the trough."

Faraday spent a month carrying out a large number of experiments on the intensity required to produce electrolysis of different solutions by varying the number of cells in the battery and seeing how many were required to electrolyse various compounds in solution or in a fused state. One of his difficulties was that he had no unit to measure by, and on February 10th he notes, " The power of decomposing water a good unit of intensity in voltaic apparatus."

The general result of these experiments was to strengthen Faraday's conviction that the source of the current was the chemical reaction taking place in the voltaic cell and not the mere contact of two metals, and indeed he proved that a current is produced without such contact by interposing a slip of paper moistened with potassium iodide solution between the metals. His thoughts were concentrated on the relation between chemical action and the production of electricity, and he realised that whether a current passes or not depends on the relative magnitudes of the chemical affinities of the reactions taking place in the battery and in the electrolytic cells. In discussing this problem on February 12th he writes: " The whole arrangement seems beautifully to show that antagonism of the *chemical powers* and the Electromotive parts with the *chemical powers* and the interposed parts. The first are producing electric effects, the second opposing electric effects, and the two seem equipoised as in a balance, and in both cause and effect appear to be identical with each other. Hence chemical action merely electrical action and electric action merely chemical." Again on February 19th: " Affinity is action at both points, but is as it were connected or related by the current of electricity in the communicating wires, or in other words affinity is electricity and vice versa."

Three days later he wrote: " We seem to have the power of deciding in certain cases of chemical affinity (as of zinc with the oxygen of water) which of two modes of action of the *one power* shall be exerted. In the one mode we can transfer the power on it being able to produce elsewhere its equivalent of action, in the other it is not transferred on but exerted at the spot. The first is the case of voltaic electric production, the other the ordinary cases of chemical affinity. But both are chemical actions and due to one power or principle."

In other words Faraday saw that a chemical reaction can be carried out in two ways, either by means of a voltaic cell in which the reactants are separated by an electrolyte, or by their direct contact, and further, he identified the electro-motive force of the cell with the chemical affinity of the reaction. Half a century was to elapse before the conception of chemical affinity assumed a definite form in chemists' minds, but here Faraday anticipates our modern interpretation. His method of reasoning, too, is an instinctive recognition of the Law of Conservation of Energy, and it was in connection with the chemical theory of the cell that he wrote in 1840: " In no case . . . . is there a pure creation or production of power without a corresponding exhaustion of something to supply it."

All these results were collected in a paper, " On the Electricity of the Voltaic Pile," and communicated to the Royal Society on April 7th. This was really the last of Faraday's great contributions to electro-chemistry, although a few papers of minor importance came later. The intensity of the current was a much more complex problem than electro-chemical equivalents, and Faraday only succeeded in associating it with the chemical affinity of the reaction in the cell. A quantitative solution of the relationships between electromotive force, the resistance of the circuit and of the electrolyte, and current strength was only possible in the light of Ohm's Law. This had been published in 1827, but Faraday could not read German, and apparently did not know of it during the period of his electro-chemical researches; so that elucidation of the quantitative relationships between the factors he was considering was left to a later generation of physicists.

Faraday's researches had a most profound and immediate effect on the progress of electro-chemistry. Within two years he changed the whole aspect of the subject and gave it a coherent structure and a quantitative basis, as a result of his laws of electro-

lysis, his new ideas which were crystallised in his new nomenclature, and his association of the intensity of the voltaic cell with the chemical affinity of the reaction taking place in it. To-day his ideas seem to us so clear and obvious that it is hard to appreciate their significance to his contemporaries. Faraday's success was due primarily to the instinct which guided him unerringly through the maze of experimental facts which might so often have led him astray, and kept as his objective the fundamental factors in each problem. Undoubtedly he was helped enormously by his wide knowledge of chemistry and the properties of chemical substances. He was never deterred by experimental difficulties, and there was a masterly touch in the simple and direct solutions he found of them. Faraday's electro-chemical researches rank among the highest of his achievements. They were carried out in a short space of time with amazing economy of effort, thanks to the combination in him of brilliant imagination, unerring instinct for essentials, and unrivalled mastery of experimental technique.

It is remarkable how many of Faraday's ideas and discoveries had a decisive influence on the development of electrochemistry in the nineteenth century, and have even to-day a direct bearing on modern theories. His experiment on the transfer of sulphuric acid during electrolysis inspired the investigation of Daniell, which proved that the current in aqueous solution is carried by the ions of the solute, and not as Faraday supposed by the ions of hydrogen and oxygen. Later its development of Hittorf led to the conception of transport numbers, which has played so important a part in the theory of solutions.

Again, in 1834, Faraday pointed out that if "we adopt the atomic theory or phraseology then the atoms of bodies . . . . have equal quantities of electricity associated with them." Had he been a believer in the atomic theory he might have made the deduction that electricity, like matter, is atomic in nature. It was left most appropriately to Helmholtz in his Faraday lecture given in this theatre in 1881, to point out this most startling result of Faraday's laws: "If we accept the hypothesis that the elementary substances are composed of atoms, we cannot avoid concluding that electricity also, positive as well as negative, is divided into elementary portions, which behave like atoms of electricity." Thus Faraday's laws lead directly to the conception of the electron.

One further example. Faraday first pointed out the enormous size of the electrical charge carried by each ion. Chemists and physicists lost sight of this fact until Helmholtz recalled their attention to it fifty years later in his Faraday lecture, and showed that the attractive force between the electrical charges associated with hydrogen and oxygen is 71,000 billion times greater than the gravitational attraction between their masses. The next twenty years saw the rise of the ionic theory of Arrhenius and Ostwald, and its many triumphs in the field of weak electrolytes, but it always failed to account for the behaviour of strong electrolytes. These were said to be anomalous because they did not conform to a theory which neglected entirely these vast interionic forces. It was not until 1912 that Milner proved that as a result of interionic forces the ions are not distributed at random in a solution, and that there must be an excess of positive ions in the neighbourhood of each negative ion and vice versa. Each ion must therefore be regarded as surrounded by an ionic atmosphere of the opposite kind, and Milner was able to show that the effect of the atmosphere on the central ion accounted for certain of the properties of strong electrolytes. In 1923 Debye and Hückel found a general mathematical solution of the problem of interionic forces in dilute solutions, and succeeded in calculating the effect of dilution on both the activity and mobility of any ion, on the assumption of complete dissociation. There is thus a direct line between the observation made by Faraday and the most modern theory of solutions.

This illustrates once again the marvellous intuition which guided Faraday to the fundamental aspects of any problem. As Kohlrausch said of him: "Er riecht die Wahrheit"— he smells the truth; or in Tyndall's words, "Faraday was more than a philosopher: he was a prophet."

MULLER-HILGER UNIVERSAL DOUBLE MONOCHROMATOR.

For many problems arising in a physical laboratory and in physical-chemistry, organic chemistry and biochemistry, it is necessary to utilise powerful radiations which are strictly monochromatic.

The Müller-Hilger Universal Double Monochromator, embodying the principle of double spectroscopic purification of radiation, is specially suitable for such work. It is of an original form of construction and is the subject of several patents in England and abroad.

Both wavelength setting and focussing are simultaneously effected for the whole instrument by means of a single adjusting drum which is engraved to read in wavelengths. The optical system has an aperture of 60 mm. diameter and is of crystalline quartz. The range of the standard instrument extends from 0.185μ in the ultra-violet to 4.0μ in the infra-red, and the relative aperture of the instrument varies from F/4 for wavelength 0.185μ to F/5.8 for 4.0μ. Its dispersion is approximately equivalent to that of four 60° prisms. Provision is made for the attachment of a sensitive thermo-element.

LEAD POISONING HAS NO TERRORS NOW.

"Practically a Thing of the Past," Says Battery Manufacturer.

Lead poisoning, that terrible menace which at one time threatened the health of every lead worker, has at last been conquered, according to Mr. W. S. Naylor, Chairman of the Chloride Electrical Storage Co., Ltd.

Speaking at the ordinary general meeting at the Exide Works, Clifton Junction, near Manchester, on Friday, May 28, Mr. Naylor said that whilst sporadic cases of plumbism might occur from time to time, he could state that as the result of the medical research carried out at Clifton Junction, together with the very comprehensive regulations issued by the Home Office, lead poisoning in their accumulator factories was practically a thing of the past.

"The information we have collected from our research," he added, "is at the disposal of the accumulator trade, or any trade where the employees may be exposed to the risk of lead poisoning."

Referring to the Company's export trade Mr. Naylor said that a large section of the total had been affected by the low prices of primary products, the restrictions on foreign exchange transactions and by tariffs.

Their trading policy had for many years made importations of accumulators impracticable, but, on the other hand, some of their raw materials had been increased in price by the imposition of British tariffs, or the imposition, by the suppliers, of a premium on non-dutiable Empire materials. The only branch of the business which had benefited by the new tariffs was the manufacture of dry batteries.

THE UNITED STEEL COMPANIES LIMITED and MESSRS. STEWART & LLOYDS LIMITED.

The new situation brought about by the imposition of tariffs encourages and requires undertakings in the Steel and complementary trades to plan for the future and to enter into arrangements having for their object the economic development of the industry and the prevention of overlapping and duplication of plant for those markets where the productive capacity is already fully sufficient for the demand.

Messrs. Stewart & Lloyds Limited and The United Steel Companies Limited are of opinion that such development of the Steel Industry is in the national interest and believe that the expression of an intention by two or more undertakings to co-operate in a general policy will be helpful in advancing this object.

The two Companies therefore have agreed :—

1. To co-operate in the policy of extensions in steel production and avoidance of uneconomic duplication of plant.
2. To co-operate in sales policy.
3. To co-operate in research, technical development and production methods.

INTERESTING WEDDING.

INDUSTRIALIST'S DAUGHTER AND A LONDON BUSINESS MAN.

The wedding took place at St. Columba's, Pont Street, London, on Saturday, June 4, of Miss Barbara Siddall and Mr. Stuart Digby Mitchell, whose family has been prominent in City linen trade circles for several generations. The bride's father, Mr. James Lister Siddall, is well-known for the active part he took in the development of South Africa after the War. He was formerly director of the Cape Argus Company and of several diamond and gold mines. He is now the Managing Director of I.C.I. Metals, Ltd.

A NEW STEEL FLOORING.

The development of a new steel flooring after long scientific investigation has been announced by Mellon Institute of Industrial Research, Pittsburgh, Pa. This flooring consists of slabs, 24 inches wide and up to 12 feet 5 inches in length at present, that are fabricated by pre-forming two steel sheets and subsequently welding them together in the plane above the neutral axis. A cross-section taken through the width of a completed unit shows four keystone-shaped cells, all connected together near the neutral axis. These four ducts, which constitute each unit, are spaced at six-inch intervals and connect directly, when installed, with the corresponding ducts of the adjacent section of floor slab. This arrangement is described as enabling the utilization of the new floor not only as an efficient load-carrying member, but also as a multiple floor-duct system for handling all types of electrical lines. Such a grouping of parallel cells with six-inch spacing is claimed to permit, at any time, the installation of electrical outlets within a radius of three inches from the exact location required, thus providing permanent electrical flexibility and precluding electrical obsolescence.

It is said that the keystone slab can be installed with ease and rapidity; that it can be bolted, clipped, or welded into place across the structural members, affording a working floor for the various trades. This floor is fire-safe; it is adaptable to appropriate finishes and to suspended ceilings and service piping, and has a low weight per square foot.

CHANGE OF ADDRESS.

PRICE, STUTFIELD & CO., LTD., have moved to larger offices at Dominion House, 110, Fenchurch Street, London, E.C. 3. This change is necessitated by the steady growth of their business as Sulphur & Chemical Merchants and more especially by the rapid expansion of the department dealing with the "ACTICARBONE" process of Solvent Recovery by the use of the activated carbons of this Trade Mark.

Proceedings and Notices of Societies.

SOCIETY OF GLASS TECHNOLOGY.

The One hundred and forty-fourth Ordinary General Meeting of the Society of Glass Technology was held in the Science Museum, London. Two sessions were held, the first on Tuesday, May 24th, at 7.30 p.m., the second on Wednesday, May 25th, at 2.15 p.m. The President, Edward Meigh, Esq., M.B.E., M.Sc., occupied the Chair at both sessions.

The first session was devoted to an address by Professor G. T. Morgan, O.B.E., D.Sc., F.R.S. (President of the Society of Chemical Industry), who spoke on "Some Research Problems in Applied Chemistry."

Professor Morgan delivered a delightfully interesting address, describing a few typical research problems which had presented themselves to the scientific staff of the Chemical Research Laboratory at Teddington. This Laboratory has been in existence some 6½ years, and is devoted to problems in various branches of inorganic and organic chemistry, being equipped so that experiments can be carried on quantitatively on a semi-works scale, when desired.

Tar Research.

The formation of several varieties of tar was described, and the importance of being able to utilise this vast by-product was indicated. The newest variety of tar—low temperature tar—a product of the present century, produced by carbonisation of coal at temperatures of 450°-650°, presented an anomaly, in that some of its constituents were sensitive to heat, being decomposed at temperatures as low as 150°. Methods for examining this tar were described; the plant was illustrated by lantern slides, and the chemical constituents which had been isolated and identified, were enumerated. This research had shown that this tar contained two main classes of substances, (a) crystalloids, including the phenols, acids, bases, and hydrocarbons; and (b) resinoids, a non-crystallisable group of materials resembling in other respects the four chemical groups mentioned. It was found that as the temperature of carbonisation was raised the resinoids disappeared, being replaced by more complex, sparingly soluble materials

grouped under the generic name of "free carbon."

Aqueous Liquors of Tar.

The temperature of carbonisation also affected the nature of the aqueous liquors accompanying the tar, being acidic at 450°, neutral at 510°, and at 650° ammoniacal. The full examination of these liquors had shown that they too contained crystalloids and resinoids.

Catalytic Reactions under Pressure.

Several instances of the great progress made in the synthesis of chemicals were given, and the production of methyl alcohol by condensation of carbon monoxide and hydrogen was described. The nature of the product obtained had been found to vary when the catalyst was varied, the addition of alkali yielding less methyl alcohol, with greater proportion of the higher alcohols, while cobalt chromate added to the zinc chromate catalyst resulted in the production of a considerable proportion of ethyl alcohol. Specimens of the catalysts used, and of the many alcohols, aldehydes, and ketones produced, were shown.

Extraction of Helium.

Helium was evolved from Monazite sand treated with concentrated sulphuric acid, or heated strongly, and the 99.5% pure gas had been produced and compressed in cylinders at Teddington. A full account of the plant was given.

Autoclaves.

The various stages in the development of the autoclave were indicated, specimens of several interesting types being displayed, some being made from military, and naval armour piercing shell. The latest type, capable of working at pressures above 50 atmospheres, was made of heat resisting steel, and was fitted with pressure gauge, inlet and outlet valves, and stirring gear of special type.

Particulars were given of the many uses to which autoclaves had been put, including the hydrogenation of tar products, in which non-volatile resins were hydrogenated to light oils; the dehydrogenation of pyridine by means of ferric chloride and the carbonylation of organic compounds by means of carbon dioxide, in presence of a catalyst, yielding some drugs and dye intermediatos.

In certain operations involving the use of ammonium chloride, the autoclave lining had been found to be seriously and quickly corroded. A silver container had shown much greater resistance under these conditions than had the stainless steel.

Researches upon the corrosion of metals in air and in solutions were described, the corrosion of steel being found to be accelerated considerably when the atmosphere above was under compression.

Other researches on the production of synthetic resins were outlined, this work being linked up with that on tar. Some of the alcohol-soluble resins termed "Novolaks" served as substitutes for shellac. Alkaline condensations led to insoluble shellac. Alkaline condensations led to insoluble Bakelites, the most important commercial variety of resins.

Since resins derived from coal tar products tend to darken in colour on exposure, research was being made for a resin which would not suffer discoloration, and also which would resist the action of water. Specimens of synthetic resins were shown, one in particular being of great interest, since it was colourless, and insoluble. Further problems including water softening and purification could not be described owing to lack of time, but it was apparent that there was no finality in chemical research.

Professor Morgan illustrated his remarks by numerous lantern slides and a wonderful range of interesting specimens which were displayed in a delightful manner.

On the Tuesday afternoon two papers were presented as follows:—

The Electrical Conductivity of Sodium-Metasilicate-Silica Glasses. By E. Seddon, B.Sc., Ph.D.; E. J. Tippet, B.Sc., Ph.D., and Professor W. E. S. Turner.

In presenting this paper, Dr. Seddon briefly reviewed the work on this subject done by Gehlhoff and Thomas; Fulda; and Schwarz and Halberstadt. The present investigation was confined to a series of two

component glasses, namely those containing soda and silica. The influence of temperature upon the electrical conductivity of each member of the series was investigated from room temperature up to the softening point, cylindrical specimens being employed. The glasses were melted from pure chemicals, in a platinum crucible to ensure purity of composition.

Measurements of the electrical conductivity were carried out in vacuo in a thick-walled fused silica vessel fitted inside an electric furnace. The electrodes were of platinum.

The specific resistances observed varied from 10^9 ohms/cc to 10^2 ohms/cc, hence the direct deflection method of measurement was employed. Full particulars of the apparatus used, and of the measurements made, were given. The relation between the conductivity and temperature was shown graphically, the logarithm of the specific resistance being plotted against the inverse of the absolute temperature. The relationship was linear, and it was seen that the electrical conductivity of a glass in the strained state was greater than when annealed. In fact, at moderate temperatures the insulating properties of the strained glass were only one third the value shown by the annealed glass.

Examination of the results obtained showed that linear relationship prevailed from 15° to 350°, then the direction of the graph changed for some glasses, the slope becoming steeper. For the majority of the glasses a transition occurred near 390°, a further more definite transition taking place at the lower annealing point the transformation temperature. Good agreement was obtained between the transformation points given by electrical conductivity and by expansion measurements.

Considering the effect of chemical composition upon the conductivity it was shown that an increase in soda content led to an increase in the sodium atoms available for ionisation, and hence to a greater conductivity of the glasses.

The agreement between the results of the present investigation and those obtained by earlier workers was discussed, and it was hoped that further conclusions as to the nature of glass, and the mechanism for the transition points might be the outcome of this work on pure, two component glasses.

The Colour of Selenium Ruby Glass. By H. P. Rooksby, B.Sc., A.Inst.P. (Communication from the Research Laboratories of the General Electric Co., Ltd., Wembley.)

Mr. Rooksby explained how the attainment of colour in a selenium ruby glass was often a matter of trial and error, and an endeavour had been made to ascertain the cause of the colour so as to enable the manufacture of such glasses to be placed upon a sounder basis. Existing theories of the cause of the colour in gold, copper, and selenium rubies were briefly indicated, then the speaker described the results which he had obtained in an X-ray examination of a number of selenium ruby glasses. In copper and gold rubies, the presence of colloidal particles was confirmed.

The selenium glasses contained zinc, cadmium, and boron as special constituents. The coloration was found to be caused by the precipitation of particles composed of a solid solution of cadmium sulphide and cadmium selenide. These particles were identical with those obtained in red pigments. Cadmium sulphide is yellow, while the selenide is dark red, and it was found that differences in the relative amounts of these two compounds in solid solution produced, in the glasses, colours ranging from deep ruby to orange. The particles in deep ruby glasses contained relatively more selenide than did those in orange-coloured glasses.

It was suggested that the colour of the glasses was largely due to the colour of the precipitated particles rather than to their size and nature, in the case of gold and copper rubies. It was further shown that selenium glasses could be classified broadly into two types, one in which colour was essentially independent of heat development treatment, and the other in which the colour varied with the temperature of development. For a stable colour, the cadmium content should be relatively high, and it appeared that any colour could be obtained by appropriate adjustment of the selenium to cadmium sulphide ratio in the batch.

THE SOCIETY OF PUBLIC ANALYSTS,
Wednesday, June 1st, 1932.

The Determination of Aluminium in Foods, by L. H. Lampitt, D.Sc., F.I.C., and N. D. Sylvester, M.Sc., A.I.C.

A method is outlined for the accurate determination of small amounts of aluminium in foodstuffs, in which the Aurin tricarboxylic acid lake is formed under standardised conditions, the red colour of the final solution being measured in the Lovibond tintometer.

Separation of aluminium from the "wet ash" of the foodstuff is effected by a preliminary precipitation with ammonia, the aluminium being obtained in alkaline solution. Other metals which are liable to be present have been proved not to interfere.

The actual determination is carried out on an aliquot portion containing 0.01 to 0.06 mgrm. of aluminium. Using 20 gm. of sample as little as 0.2 parts per million of aluminium can be determined. Some results are given which indicate that the aluminium content of foodstuffs is increased by only a few parts per million after cooking in aluminium utensils. For example, the aluminium content of milk was increased from 0.4 to 0.6 part per million after boiling in an aluminium saucepan, and to 2.5 parts per million after standing overnight. Apples before cooking contained 2 parts per million of aluminium, and after boiling in an aluminium vessel for 30 minutes with sugar and water they contained 14 parts.

The Spectrographic Determination of Small Quantities of Aluminium, by P. L. Bilham, B.Sc., A.I.C.

A method of concentrating the aluminium content of a biological material on to an electrode has been devised so that no possible loss occurs. The spectrum is then excited by a condensed spark discharge modified to remove air-lines as much as possible, and a quartz spectrograph is employed to photograph the spectrum. The plate is developed under standard conditions and then compared with sets of standards on plates prepared under precisely similar conditions. The results show that aluminium is detectable down to 0.01 mgrm., and that the intensities of the lines at 3944A and 3961.5A can be used to judge the amount present up to 0.2 mgrm. The method is, of course, specific for aluminium and of a reasonable accuracy.

The Physiological Effects of Aluminium, by J. H. Burn, M.A., M.D.

The first extensive investigation of the physiological effects of aluminium salts was made in 1886 by Siem, working under Prof. H. H. Meyer. Siem found that doses corresponding with 30 to 40 grains of alumina for a man, had no effect whatever when administered by mouth to cats daily for four weeks. When the aluminium salt was injected under the skin, the fatal dose varied from 0.25 to 0.30 grm. of alumina per kilogram. These results, indicating that aluminium has some toxicity when injected, but is harmless by mouth, have in substance been confirmed by many subsequent workers.

Siebert and Wells examined the pathological changes produced by injecting alum and aluminium chloride; they found that anæmia was manifested after nine or ten daily injections, a fall in the hæmoglobin percentage and in the red cell count being recorded. In the spleen, pigmentation, thrombosis and fibrosis were observed.

The experiments of McCollum and his colleagues, and those of Myers and Mull, show conclusively that the addition of aluminium salts to the diet of young rats has no ill effect on growth, health and reproduction, even when four successive generations are observed.

The experiments of Myers and Morrison, and of Underhill and Peterman, show that when aluminium compounds are given by mouth to dogs, only insignificant changes in the amounts of aluminium in different tissues are found; it follows that aluminium salts are not absorbed from the alimentary tract, except in traces.

As a result of a scare in the United States that the use of aluminium baking powders was dangerous to health, the Department of Agriculture instituted a board of inquiry. The report, published in 1914, describes experiments on twenty-six university students carried out in three different universities, who were given amounts of alum varying from 0.2 grm. to 10 grms. daily for about six months. It was unanimously reported from the results of these experiments that the amounts of alum likely to be consumed as a result of alum in baking powder, estimated as up to 1.16 grain of aluminium per person per day, are much too small to have any ill effect. The amounts of aluminium which arise from aluminium vessels are estimated from analyses carried out by Massatch to be about 0.1 grain per person daily.

It is seen that the dangers arising from aluminium utensils have been very thoroughly investigated by many workers, on many species of animals; they have also been investigated with equal thoroughness on man. These dangers are non-existent. Clinical reports that symtoms of abdominal pain are relieved by discontinuing the use of aluminium must be ascribed to psychological effects, which are very common in medical practice.

ROYAL INSTITUTION.

A General Meeting of the Members of the Royal Institution was held on June 6, Sir Robert Robertson, Treasurer and Vice-President, in the Chair. The Chairman reported on behalf of the Managers that they had received from the Becker family a gift of a number of Faraday letters; from Mr. D. O. Wollaston, Dr. Wollaston's Camera Lucida; and from Professor J. C. M'Lennan the apparatus in which the liquid helium, used in the demonstration at his evening discourse last Friday, was transported from Holland. Mr. Cecil Rowntree was elected a Member.

Notices of Books.

Genius and Criminal—a study in rebellion, by HENRY T. F. RHODES. Pp. x + 318. Price 7s. 6d. John Murray, London.

The author of this brilliant book is probably better known to readers of the *Chemical News* as the Editor of the *Chemical Practitioner* and a one-time General Secretary of The British Association of Chemists, than as an author of books outside of the field of Chemistry. His other book, *Some Persons Unknown,* is a brilliant exposition of the application of science to criminological problems, and the subject of the present review is indeed a worthy successor. Mr. Rhodes' work on forensic science has already admitted him to the ranks of the International Academy of Criminology and I venture to suggest that would-be writers of detective stories would he well-advised to read this little volume, the authors' previous work and Dr. C. A. Mitchell's *Scientific Detective,* and then perhaps, faulty hypotheses in their work would be eliminated. In this present work, the author presents the view that genius and criminal are linked in kinship, and that both are up in arms against their environment. Either they break through (that is become great minds in service to humanity or in crime), or are themselves broken in the struggle. The book is divided into sections unique in themselves, namely: Approach to the study of the Criminal and Genius type, Examples (*a*) *The Criminal Trend,* (*b*) *The Genius Trend.* Problems. Retrospect. A noteworthy feature is the manner in which Mr. Rhodes first states his argument and then proceeds to support and illustrate it by examples of the lives of notorious criminals and certain actual men of acknowledged genius. In every instance these examples may be taken as typical, either of the genius or the criminal.

On the whole this book is an extremely interesting study and a distinct contribution to sociology. It may be provocative, but I feel sure that what doubts (if any) Mr. Rhodes has not dispelled in the actual text, he is quite capable of clearing away to the complete satisfaction of the enquirer.

H. W. B. R.

New Patents.

These particulars of New Patents of interest to readers have been selected from the Official Journal of Patents and are published by permission of the Controller of H.M. Stationery Office, and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

Latest Patent Applications.

15,118.—Ashcroft, E. A.—Preparation of copper sulphate for ores, etc. May 27th.

14,122.—Ashcroft, E. A.—Electrolysis of zinc, etc., chloride. May 27th.

14,775.—Imperial Chemical Industries, Ltd., & Lemmon, R. J.—Treating cyanide solutions. May 24th.

14,549.—Mond, A. L.—(Chemische Fabrik Buckau). Decomposition of complex salts composed of sulphates of alkali metals, etc. May 23rd.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, at the uniform price of 1/- each.

Abstract Published.

Group Abridgements can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, either sheet by sheet as issued on payment of a subscription of 5/- per Group Volume or in bound volumes price 2/- each.

367,525.—Aluminium oxide, nitrogen oxides.—Blanc, G. A., 5, Viale Rossini, Rome.

A process for producing aluminium oxide by heating hydrated aluminium nitrate is characterized in that the heating is effected in stages. In the first stage, the nitrate is fused in its water of crystallization at a temperature not exceeding 150° C., until 40 per cent. of the water and nitric acid is evolved; the material approaching solidification is then heated to a temperature not exceeding 250° C. until 75 per cent. of the water and acid is evolved, and in the third stage above 250° C., but not exceeding 450-500° C., when complete decomposition is effected. By operating in this manner, the production of lower oxides of nitrogen is reduced to a minimum.

The Latest Trade Marks.

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of H.M. Stationery Office, and the Trade Marks Journal can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

GLYACON.

528,446.—Chemical substances for use as solvents or as softening agents in the course of the manufacture of lacquers or of cellulose derivatives or of articles made from cellulose derivatives.—C. F. Boehringer & Soehne Gesellschaft Mit Beschrankter, Sandhoferstrasse, 112 to 132, Mannheim-Waldhof, Germany. June 1st.

FIBROTOL.

530,735.—Chemical substances included in Class 1 for use in the treatment of textile fabrics and leather in the course of their manufacture.—H. TH. Böhme Aktiengesellschaft, 29, Moritzstrasse, Chemnitz, Germany. June 1st. (By Consent).

VUTOX.

530,397.—Chemical substances used for veterinary and sanitary purposes, but not including liniment or embrocation, and not including any goods of a like kind to liniment or embrocation.—Pharmaceutical Corporation Limited, 39, Aldersgate Street, London, E.C. 1. June 1st. (Associated.)

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Edited by H. W. BLOOD RYAN, M.A., D.Sc., LL.D., Ph.D.

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THE COLLINSICS OF MINERALS. XXII.

By HAWKSWORTH COLLINS, B.A.(Camb.).

The voloptic of carbon (8.0, 3.333) has been demonstrated 35 times in the first 316 collinsics. This means that its relative volume is 8, and its optical refractivity 3.333. But in the following 18 minerals, whilst its R.V. is still 8, its O.R. is frequently represented by the same number instead of 3.333. This voloptic (8.0, 8.0) will occur later hundreds of times in organic substances. In Table LVIII it occurs 33 times.

A possible explanation of these facts is that when the O.R. of carbon is 8 the atom is lying lengthwise to the ray of light, and when the O.R. is 3.333, it is lying at right angles to the ray; so that in No. 303, *e.g.*, the atoms of C are alternately at right angles to one another.

These matters are not demonstrable by direct experiment, they can only be made evident by methodical differentiations such as appear in the collinsics. An exactly similar state of affairs was shown to be the case with regard to sulphur in C.N. 1931, CXLII, 323; where the voloptic of S is either 15.53, 5.75 or 15.53, 15.53; of which the former has been demonstrated 47 times, and the latter eleven times in the first 316 collinsics.

The voloptics employed in Table LVIII are given in Table LVII, which is intended to be read as follows:—When ferrous iron has relative volume 11.64 its optical refractivity is 10.08, *and this voloptic has already occurred 17 times in the first 316 collinsics, etc.*

TABLE LVII.

	R.V.	O.R.	No. of Times.
Fe″	11.64	10.08	17
Am	23.87	9.81	16
Ca	13.25	13.25	31
Fe″	7.05	8.374	6
Al	9.05	7.865	146
Mg	7.51	5.031	23
Mg	13.69	9.023	16
Mg	8.71	6.0015	67
Ca	12.24	15.6885	13
Ba	24.58	12.864	5
Na	11.865	3.865	82
Li	6.21	3.55	5
C	8	3.333	35
C	8	8	33
O	7.53	1.654	409
O	4.45	1.747	370
O	2.51	1.346	2166
H	5.76	2.613	1353

For the sake of those who have not seen the collinsics before it is necessary to explain one as shortly as possible. In No. 314 if the molecular weight 74 be divided by 2.111 the result is 35.05. When this is multiplied by 0.57 (n — L) the product is 19.98. Therefore in order that it may be possible to solve this collinsic by means of all the facts

which have so far been demonstrated, it is necessary that the molecular volume should be about 35 and the total O.R. about 20. The only known voloptic of lithium is 6.21, 3.55, and the average O.R. of oxygen is about 1.5. So the approximate sum of O.R.s of the two lithium-atoms and of the three oxygen-atoms is $2 \times 3.55 + 3 \times 1.5 = 11.6$; and it is evident that the O.R. of carbon must be 8, making the total sum nearly 20, as required.

Again, in order that the total of the relative volumes may be approximately 35 one of the oxygen-atoms must have R.V. 7.53 and another 4.45. The collinsic is thus obtained, as given in No. 314, and there is no other possible interpretation of the facts.

If anyone had tried to solve this collinsic by means of the voloptics of the preceding 298 collinsics, he would have found it impossible, because nothing so far had been said about this other voloptic of carbon. It is therefore evident that nobody can condemn the collinsics by stating that a certain mineral cannot be solved by the voloptics which have so far been demonstrated.

TABLE LVIII.

(299) Humboldtite $Fe''C_2O_4.2H_2O$

Theor. S.G.		2.26		Obs. S.G.		2.28W
		Fe	C_2	O_2	O_2	aq_2
46.0275	=	0.5778(11.64	+ 8_2	+ 7.53_2	+ 4.45_2	+ 14.03_2)
Theor. R.I.		1.5778		N_m 1.561W		N_g 1.692W
46.026	=	10.08	+ 8_2	+ 1.654_2	+ 1.747_2	+ 6.572_2

(300) Oxammite $Am_2C_2O_4.H_2O$

Theor. S.G.		1.486		Obs. S.G.	1.48 ± W
		Am_2	C_2	O_4	aq
49.180	=	0.5146(23.87_2	+ 8_2	+ 4.45_4	+ 14.03)
Theor. R.I.		1.5146	Obs. R.I.	N_m1.547W	N_p1.438W
49.180	=	9.81_2	+ 8_2	+ 1.747_4	+ 6.572

(301) Whewellite $CaC_2O_4.H_2O$

Theor. S.G.		2.236			Obs. S.G.		2.23W
	Ca	C	C	O_2	O	O	aq
37.554 =	0.5751(13.25	+ 8	+ 8	+ 7.53_2	+ 4.45	+ 2.51	+ 14.03)
Theor. R.I.		1.5751		Obs. R.I.	1.555 — 1.650	CRPC.	
37.556 =	13.25	+ 8	+ 3.333	+ 1.654_2	+ 1.747	+ 1.346	+ 6.572

(302) Ferrodolomite $CaFe''C_2O_4$

Theor. S.G.		3.584			Obs. S.G.	3.6W
	Ca	Fe	C_2	O	O_2	O_3
46.81 =	0.7768(13.25	+ 7.05	+ 8_2	+ 7.53	+ 4.45_2	+ 2.51_3)
Theor. R.I.		1.7768			Obs. R.I.	1.776W
46.81 =	13.25	+ 8.374	+ 8_2	+ 1.654	+ 1.747_2	+ 1.346_3

(303) Mellite $Al_2C_{12}O_{12}.18H_2O$

Theor. S.G.		1.6427		Obs. S.G.	1.642	Kenngott	
	Al_2	C_6	C_6	O_6	O_4	O_2	aq_{18}
221.623 =	0.5099(9.05_2	+ 8_6	+ 8	+ 7.53_6	+ 4.45_4	+ 2.51_2	+ 14.03_{18})
Theor. R.I.		1.5099		Obs. R.I.	1.50785 — 1.51101	D	
221.628 =	7.865_2	+ 8_6	+ 3.333_6	+ 1.654_6	+ 1.747_4	+ 1.346_2	+ 6.572_{18}

(304) Hydromagnesite $3MgCO_3.MgO_2H_2.3H_2O$

Theor. S.G. 2.16 Obs. S.G. 2.16 D

$$89.805 = 0.53303(\overset{Mg_3}{7.51_3} + \overset{Mg}{13.69} + \overset{C_3}{8_3} + \overset{O_5}{7.53_5} + \overset{O}{4.45} + \overset{O_5}{2.51_5} + \overset{H_2}{5.76_2} + \overset{aq_3}{14.03_3})$$

Theor. R.I. 1.53303 Obs. R.I. 1.527 — 1.54 S. N_m1.530 Larsen

$$89.805 = 5.031_3 + 9.023 + 8_3 + 1.654_5 + 1.747 + 1.346_5 + 2.613_2 + 6.572_3$$

(305) Dolomite $CaCO_3.MgCO_3$

Theor. S.G. 2.89 Obs. S.G. 2.87 W

$$43.505 = 0.6835(\overset{Ca}{12.24} + \overset{Mg}{8.71} + \overset{C}{8} + \overset{C}{8} + \overset{O_6}{4.45_6})$$

Theor. R.I. 1.6835 Obs. R.I. 1.68174 D 1.682 C.R.P.C.

$$43.505 = 15.6885 + 6.0015 + 3.333 + 8 + 1.747_6$$

(306) Witherite $BaCO_3$

Theor. S.G. 4.343 Obs. S.G. 4.3 M 4.35 D

$$25.214 = 0.5587(\overset{Ba}{24.58} + \overset{C}{8} + \overset{O}{7.53} + \overset{O_2}{2.51_2})$$

Theor. R.I. 1.5587 Obs. R.I. 1.529 — 1.677 S

$$25.21 = 12.864 + 8 + 1.654 + 1.346_2$$

(307) Siderite, $Fe''CO_3$

Theor. S.G. 3.736 Obs. S.G. 3.796 O° Kopp 3.698 Brei

$$22.921 = 0.7382(\overset{Fe}{11.64} + \overset{C}{8} + \overset{O_2}{4.45_2} + \overset{O}{2.51})$$

Theor. R.I. 1.7382 Obs. R.I. 1.75 M. N_e 1.747 W

$$22.920 = 10.08 + 8 + 1.747_2 + 1.346$$

(308) Northupite $MgNa_2C_2O_6.NaCl$

Theor. S.G. 2.38 Obs. S.G. 2.380 D

$$53.9102 = 0.51653(\overset{Mg}{8.71} + \overset{Na_2}{11.865_3} + \overset{C_2}{8_2} + \overset{O_2}{7.53_2} + \overset{O_2}{4.45_2} + \overset{O_2}{2.51_2} + \overset{Cl}{15.085})$$

Theor. R.I. 1.51653 Obs. R.I. 1.5144 D

$$53.9105 = 6.0015 + 3.865_3 + 8_2 + 1.654_2 + 1.747_2 + 1.346_2 + 10.82$$

(309) Barytocalcite $CaBaC_2O_6$

Theor. S.G. 3.706 Obs. S.G. 3.706 D

$$53.642 = 0.6717(\overset{Ca}{12.24} + \overset{Ba}{24.58} + \overset{C_2}{8_2} + \overset{O_2}{7.53_2} + \overset{O}{4.45} + \overset{O_3}{2.51_3})$$

Theor. R.I. 1.6717 Obs. R.I. 1.686 — 1.525 W N_m1.684 W

$$53.6455 = 15.6885 + 12.864 + 8_2 + 1.654_2 + 1.747 + 1.346_3$$

(310) Magnesite $MgCO_3$

Theor. S.G. 2.99 Obs. S.G. 3.0 D

$$18.8404 = 0.67(\overset{Mg}{8.71} + \overset{C}{8} + \overset{O_2}{4.45_2} + \overset{O}{2.51})$$

Theor. R.I. 1.67 Obs. R.I. N_o1.700 W N_e1.509 W

$$18.8415 = 6.0015 + 8 + 1.747_2 + 1.346$$

(311) Ammonium Hydrogen carbonate $AmHCO_3$

Theor. S.G. 1.574 Obs. S.G. 1.586 CRPC

$$24.769 = 0.4936(\overset{Am}{23.87} + \overset{H}{5.76} + \overset{C}{8} + \overset{O}{7.53} + \overset{O_2}{2.51_2})$$

Theor. R.I. 1.4936 Obs. R.I. 1.5358 — 1.4227 CRPC

$$24.769 = 9.81 + 2.413 + 8 + 1.654 + 1.346_2$$

(312) Dawsonite $NaAl(OH)_2CO_3$

Theor. S.G. 2.4 Obs. S.G. 2.4 W

$$32.393 = 0.5402(11.865 + 9.05 + 5.76_2 + 8 + 7.53 + 4.45 + 2.51_3)$$

Theor. R.I. 1.5402 Obs. R.I. N_m1.542 W

$$32.395 = 3.865 + 7.865 + 2.613_2 + 8 + 1.654 + 1.747 + 1.346_3$$

(313) Tychite $Na_2SO_4.2Na_2CO_3.2MgCO_3$

Theor. S.G. 2.573 Obs. S.G. 2.59 W 2.46 W

Na_6 S C_4 Mg_2 O_5 O_2 O_9

$$104.686 = 0.516(11.865_6 + 15.53 + 8_4 + 7.51_2 + 7.53_5 + 4.45_2 + 2.51_9)$$

Theor. R.I. 1.516 Obs. R.I. 1.508 W

$$104.660 = 3.865_6 + 15.53 + 8_4 + 5.031_2 + 1.654_5 + 1.747_2 + 1.346_9$$

(314) Lithium carbonate Li_2CO_3

Theor. S.G. 2.12 Obs. S.G. 2.111 Krem.

Li_2 C O O O

$$19.846 = 0.5685(6.21_2 + 8 + 7.53 + 4.45 + 2.51)$$

Theor. R.I. 1.5685 Obs. R.I. 1.567 — 1.572

$$19.847 = 3.55_2 + 8 + 1.654 + 1.747 + 1.346$$

(315) Magnesium carbonate $MgCO_3.3H_2O$

Theor. S.G. 1.808 Obs. S.G. 1.808 CRPC

Mg C O_2 O aq_3

$$38.376 = 0.5025(8.71 + 8 + 7.53_2 + 2.51 + 14.03_3)$$

Theor. R.I. 1.5025 Obs. R.I. 1.501 CRPC

$$38.3715 = 6.0015 + 8 + 1.654_2 + 1.346 + 6.572_3$$

(316) Magnesium carbonate $MgCO_3.3H_2O$

Theor. S.G. 1.836 Obs. S.G. 1.83 — 1.84 D

Mg C O_2 O aq_3

$$37.405 = 0.4976(7.51 + 8 + 7.53_2 + 2.51 + 14.03)$$

Theor. R.I. 1.4976 Obs. R.I. 1.495 — 1.501 CRPC

$$37.401 = 5.031 + 8 + 1.654_2 + 1.346 + 6.572_3$$

Summary.

Carbon is the eleventh element which has now been shown to have the same figures for O.R. as for R.V. The other ten were enumerated in Table XLVI, C.N. 1931, CXLII, 407. These extraordinary facts are all due to the Gladstone-Dale formula.

The 316 collinsics which have so far been published are only a very small part of the whole, so that it is reasonable to suppose that this state of affairs may be extended in the future; *i.e.*, it may be expected that more than eleven elements may under certain circumstances be found to have their optical refractivities exactly equal numerically to their relative volumes.

The fundamental reason for this state of affairs is urgently required.

Directly this reason is found, the result must inevitably be the elimination from the minds of scientists of a hypothesis with regard to the structure of atoms which is misleading them.

But even before this reason is found, another question arises as to whether it is possible for anyone to find an entirely new order of things from 316 facts *re* specific gravity and 316 facts *re* refractive index, and yet not to have found the truth.

In other words, " Is it possible for 632 experimental facts to be arranged in such a way as to demonstrate the relative volume occupied by each atom in 316 minerals together with the optical refractivity of each one of these atoms, and yet for the truth not to be attained.

WHERE DOES THE CHEMIST STAND TO-DAY?*

By F. SCHOLEFIELD, M.Sc., F.I.C.

In his opening remarks Mr. Scholefield said that he was particularly interested to note the interest that was taken by chemists in Manchester and elsewhere in the modern problems of economics. We all had to consider where we stood to-day in this connexion. It was quite obvious that methods of production which scientific methods had revolutionized required a new and more scientific economic system. He was not bound to the views of any particular modern school, but all at least agreed that now that hardly any commodity had a scarcity value, that to employ an economic system on a basis of scarcity was impossible and was endangering civilisation. (Applause). The modern world was a world of plenty, that was the very basis of modern civilisation. It was an old-fashioned economic system which prevented its distribution, so that in the midst of increasing riches more and more people starved. Where did the chemist stand to-day in this connexion? It was his problem; chemistry had done more to produce that plenty than any other individual element. It was up to the chemist to solve the problem of distribution.

The fact that the chemical man was not a trained economist was not the point. The economist themselves were as much, if not more, at sea than those who had never studied classical economics. The fact was that classical economics were not designed to deal with modern problems of production and classical theory and practice was impotent. What was required was a new vision.

From another point of view, the new science of production had introduced new problems into the chemist's professional life. There was rationalization everywhere, and he foresaw the time when there would be ten or a dozen combines which would absorb, and employ all chemists, or nearly all. We had to consider the economic result, and the effect upon training. Even as it was I.C.I. took men straight from the university and trained them in its methods for five or six years. It was obvious that a man with a university degree, and five or six years' training of this kind was worth a good salary, but the tendency was for salaries to fall. He would say at once that the result of this would be inevitable and disastrous. The type of individual entering the profession would suffer—he was not certain that it had not begun to suffer already—and industrial efficiency would suffer. We would ask them to consider this in relation to the economic situation generally. We had already suffered more than enough by the study of false economy rather than genuine economics.

Where did the Association stand? It must give serious and immediate attention to this problem, and must press for—in the interests of industry itself—a maintenance and increase in the salaries paid to chemists.

From another point of view amalgamations were a problem to the chemist. In the event of his having a legitimate difference of opinion with his employer, the fact that so few remained made it almost impossible if he resigned for him to obtain another post. This was a very serious question. In the employee who was not a routine worker a certain independence of mind was inevitable, and indeed a great asset. He did not suggest that employers did not recognise this, but the larger the machine the greater was the danger of this independence being obscured to the irreparable damage of industry.

They must not suppose that he thought that this increasing tendency to amalgamate was wholly bad. On the contrary, the size and wealth of large organisations made possible the application of science to industry in increasing measure. So it had proved up to now, so it might prove in the future if properly directed and controlled.

But it was well to bear in mind that this form of capitalist enterprise no longer looked as if it would remain without a competitor in the field. It was unintelligent to ignore the phenomenon of Russian Communism and Marzian, and those who did ignore it did so either from stupidity, as the result of interested propaganda, or from prejudice. Whatever their politics were, their methods were admirable. The attitude of the Soviets

to research was an example. It was a matter of incontrovertible fact that Russia had, in some territories a research institution for one group of six factories comparable with the Shirley Institute. Russia had only begun but that was an indication of the lines upon which she was developing. The system was founded upon a negation of capitalism. There were indications that given time it would work. How did the chemist stand in this regard?

This again was related to the economic problems as most things ultimately were. It was perfectly obvious to him that the question was going to be, shall we try first the Communist experiment, or perhaps the less risky one of monetary reform? It was difficult to imagine a third alternative. If there was monetary reform he thought it possible that existing institutions could do all that he felt sure developed Communism would do; and perhaps more, since there was some foundation on which to build which Russia lacked.

These problems, vital now, were going to be of paramount importance to the younger generation, and to the young chemist in particular. Where was he going to stand, and where did the Association in relation to him? As the young chemist was satisfied or dissatisfied with his work, his pay and his conditions, so he would react to the society in which he was placed. Intellectual elements dissatisfied with their conditions were a danger to any state because they were moved to reform according to the measure of their personal dissatisfaction, rather than on account of more disinterested motives.

Unemployment had fortunately affected the chemical profession less up to now, perhaps, than any other. But it was very difficult for the young man straight from the university to get a post. Here the Association was doing and must continue to do increasingly useful work. It had to advise the young chemist who was starting on his career as to what kind of openings were available, the salary he should be able to command, and the general conditions of employment. Professional education was badly needed, and it was that type which the Association was so admirably fitted to supply

The B.A.C. was doing a great work. The thousands of pounds paid out in benefit to unemployed members alone was witness to that; and there was besides the highly successful work of the Legal Aid Department, and the Appointments Bureau. These things were absolutely essential aids to success particularly for the young chemist. They helped him to define his own position, and that in which he stood to the community.

Mr. E. N. Marchant in thanking Mr. Scholefield for his address said that he thought it was one of the most thought provoking of any which had ever been delivered before the Section. The problems to which Mr. Scholefield had drawn attention were which every scientific man and every chemist had to face. Science was evolving the perfect industrial machine, and we had to consider how that machine was going to be used.

A full discussion followed to which Dr. Hankey, Mr. Mawson, Mr. Hill, Mr. Barlow, and Mr. Rhodes contributed.

Dr. Hankey stressed the problem from the point of view of over production. Mr. Mawson was of opinion that a scientifically controlled currency regulated by production and not by gold was essential if economic chaos was to be avoided. Mr. Hill defended the gold standard, and suggested a remedy in a more rapid circulation of money.

Dr. Ward also contributed to the discussion. He was of opinion that a great deal more scientific publicity was necessary if scientific men were to play their proper part in the life of the community. There was not enough sound information in the public press concerning scientific discovery and invention. He thought that there should be provision for special organisation to provide for publicity of this kind.

Dr. Hankey proposed a vote of thanks to Mr. Scholefield, which was seconded by Mr. Morgan. This was carried with enthusiasm and acclamation.

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* An address delivered before the Manchester Section of the British Association of Chemists, on May 25th, 1932. A previous note of this function has already appeared in the *Chemical News*, and the present report has been supplied through the courtesy of Mr. H. T. F. Rhodes, the Editor of *The Chemical Practitioner.*

THE ORIGIN OF LIVING MATTER.

The analogy between the structure of the Solar System and that of the atom has led, in the Bohr atom, to results of fundamental importance, and to the presentation of an atomic picture and theory which has, in spite of recent far reaching developments in quantum mechanics, never been supplanted. The application, by Uhlenbeck and Goudsmit in 1926, of the concept of the quantised spinning electron was of epoch-making importance in the development of atomic physics, but as far as the writers are aware, no atomic application has so far been made of the astronomical principle of binary star-systems in the stellar Universe.

The object of this paper is to show that the application to contemporary atomic theory of this analogy supplies the essential factor in the formulation of a theory of living matter as distinct from dead or inert substance. A widely accepted theory attributes the origin of the Solar System to the detachment, due to the gravitational attraction on the condensed Sun of another celestial body, of a filament of matter which ultimately gave rise to a series of planets of varying mass and density, the latter being greatest in the case of the Earth. An important clue to the origin of living matter is given by the extremely high ratio of the mass of the Moon to that of the Earth, as compared with the corresponding ratio for Jupiter or Saturn and their satellites. This very high ratio suggests an entirely different manner of origin for the Moon, and one which can be explained by the passage of a celestial body, having approximately double the mass of the Earth and Moon combined, between the Earth and Mars, at such a distance from the former as to give rise to the disruption from the Earth of a filament of matter which ultimately condensed to form the Moon. The latent energy and manifestation of energy in living matter must be attributed to, and have its origin in the latent or recoil energy set free when the Moon was detached from the Earth; a further essential and simultaneous condition was that the physical state of the Earth was such as to favour the presence of water, thus creating a suitable environment.

The four characteristics distinguishing living from non-living matter, viz.: the constant emission of energy in the form of heat, the power of movement or excitability, an inability to function except in an environment of water, and the power of incorporating within itself non-living matter thereby increasing its mass and complexity with accompanying greater range of variety and function, are due to, and can be explained only by defining the atom of living matter as one consisting of A DOUBLE NUCLEUS REVOLVING ROUND A COMMON CENTRE OF GRAVITY AND SURROUNDED BY AN ELECTRONIC SYSTEM. The nuclei would be of equal or unequal mass according to the variation in properties of the vital atoms. The stability of such a system of which the potential energy would far exceed that of any mononuclear atom, follows from the existence of such binary systems in the Stellar Universe. The four above-mentioned characteristics of living matter, and all the phenomena of Life can be explained by THE FUNCTIONING OF A BINUCLEAR ATOM IN AN ENVIRONMENT OF MONONUCLEAR ATOMS. The well-known facts of stereo-isomerism and the inability of artificially controlled processes to produce an optically active compound are in accordance with the distinctive processes of vitalism occasioned by the functioning of the binuclear atom. It seems certain that experimental evidence to prove the structure of the latter can never be obtained, since any attempt at its analysis automatically creates an unsuitable environment. The creation of a vital atom must similarly be beyond the range of human ingenuity for the manner and circumstances

EDITORIAL NOTE.—The authors of this note consider that they have reached conclusions of a fundamental nature on a subject of primary scientific importance, and one which has been receiving close attention in the development of quantrum chemistry in the papers of Dirac, Bohr, Jeans and others. They further consider that the use they have made of the analogy with binary star systems supplies a link that has been, up to the present, completely overlooked, and is comparable in probable importance to the recent introduction of the concept of the spinning electron. It is understood that their theory is being developed in detail.

under which such an atom first came into being were such as can never be duplicated in the laboratory.

Our object has been to put on record a theory of the exact manner in which living matter came into being, and how it differs from inert matter. Our work is being extended and developed.

HENRY A. GRAY.
N. M. BLIGH.

21st June, 1932.
London, S.W. 1.

BRITISH STANDARD SPECIFICATION FOR THE IDENTIFICATION OF CHEMICAL PIPE LINES (B.S.S. NO. 457-1932).

The British Standards Institution has recently published a Specification for the "Identification of Chemical Pipe Lines," (British Standard Specification No. 457-1932) which deals with the marking of pipe lines carrying inflammable, explosive, toxic, and corrosive gases.

In the preparation of this specification a careful survey of the existing position in the Chemical Industry was first undertaken, which showed that, in order to ensure the general adoption of any standard system for the Identification of Chemical Pipe Lines, it was essential that it should be inexpensive to operate and simple and easy to memorise and also that the system should be such that in case of emergency it would permit of the quick and easy identification of the fluids or gases conveyed therein.

The British Standard scheme differentiates between the type or nature of the fluid or gas conveyed by means of a series of enamelled identification plates placed adjacent to the control valve and at such intervals along the pipe as deemed necessary by the user, but no attempt has been made to standardise a range of colouring and marking to indicate the many fluids or gases conveyed in pipes.

The identification plates are so designed as to suggest to the workman the nature of the fluid or gas conveyed therein and are so shaped that sufficient room is allowed at the base for the name or chemical symbol of the gas or fluid if so desired.

It is hoped that, by the adoption of this specification in connection with Chemical plants, a further step towards safeguarding those engaged in the running of chemical plants will be reached.

Copies of this B.S. Specification (No. 457-1932) may be obtained from the Publications Department, British Standards Institution, 28, Victoria Street, London, S.W. 1, price 2/2d. post free.

JOURNAL OF SCIENTIFIC INSTRUMENTS.

It is announced that a new regular monthly feature commences in the current number of the *Journal of Scientific Instruments.* For some time past it has been felt by the Journal Advisory Committee that the specialized articles on definite forms of instruments which have hitherto been the principal feature of this Journal might well be supplemented by articles of a wider scope dealing with the trend of development of various classes of instruments or with matters of general interest to instrument manufacturers and users. It is believed that the contribution of these articles by recognized authorities of long and wide experience will prove of great interest and service by giving critical surveys of present practice, and by indicating the lines upon which future progress may be expected.

Some twenty-five eminent authorities have already promised to contribute, and the subjects chosen cover a wide field.

The Journal is produced by the Institute of Physics with the co-operation of the National Physical Laboratory.

AN INTERNATIONAL CENTRE FOR CHEMICAL INFORMATION.

Wilhelm Ostwald, who had solidly laid the foundations of Physical Chemistry, died last April. No better illustration of his pioneer ideas can be given than the following extract, freely translated, from an article written by him twenty years ago. The suggestions which he wrote concerning International Chemical Science will be actual facts when the "Maison de le Chimie," now being built in Paris, is completed next year. This has been brought

about largely through the untiring efforts of M. Jean Gerard, the Secretary of the International Union of Chemistry. What the International Union of Chemistry is doing and further intends to do, for Chemistry, is also the aim of the International Faculty of Sciences in connection with all departments of scientific knowledge and work.

"The foundation of an International Chemical Union," wrote Wilhelm Ostwald, "*proves that chemistry has reached a stage* wherein individual activity must give way to organised effort. Among the proposed activities of the International Chemical Union, which can only be carried out by group work, one may mention the study of nomenclature of chemical compounds, the compilation of tables of atomic weights, uniformity in the names of chemical and physical constants, co-ordination of chemical abstracts, etc.

"This extensive programme cannot be carried out without a central institution possessing the necessary facilities, in particular a very complete library.

"This central institution will not in any sense duplicate existing research organisations. Its primary purpose will be to prevent unnecessary repetition of bibliographical and other routine work. Once carried out this will be kept at everyone's disposal and will not have to be done all over again at different places.

"The institution will undertake bibliographical researches just as the National Physical Laboratory carries out the standardisation of thermometers. Some people fear that the art of compiling bibliographies will be lost; even if it is lost by the individual chemist it will be perfected in the Institute and will always be at the disposal of every chemist so that the individual chemist will have more leisure for experimental research.

"Everyone realises that complete bibliography in any subject is rapidly becoming impossible for any individual to compile. Berzelius, during the latter part of his life, prepared yearly abstracts of the advance of the whole realm of chemistry; Beilstein's treatise of organic compounds was at first largely the outcome of one man's effort. But the work these pioneers did must now perforce be carried out by groups of workers. At present this is done mostly in Germany but it should certainly be taken up by an International Organisation seeing that it is of universal utility. The various abstracting journals cannot cope with the fast-growing needs of scientific and technical chemistry and new channels will have to be developed by the International Chemical Centre.

"Where should the International Institute be located? It must naturally be near an important city in Europe, easy of access to the largest number of chemists. It seems that a second similar Institute will have to be created in America. This work could be so organised that it will not result in duplication of effort.

"The first duty of the new Organisation will be to set up a *very complete chemical library*. To reduce the initial cost of such an undertaking all chemists may be requested to contribute a copy of their published work to the central library. Publishers of scientific periodicals and scientific societies will also be willing to supply free of charge their publications to an International Centre.

"*A complete list of chemical substances* which have been or are being prepared—together with full references to papers describing them, is the next important step. This list would enable the Institute to supply instantly, to all interested, complete bibliographies concerning any given substance. It can serve eventually to the compilation of a comprehensive chemical encyclopedia.

"No less valuable than the above enterprises would *be a dictionary of chemical terms and chemical concepts.* Like chemical compounds, scientific concepts are continually subject to a process of purification and crystallisation, and the history of their development is as important as the history of the substances themselves.

"Another useful undertaking will be *a list of chemists,* both living and dead. This could be put together in the first instance from the membership lists of all chemical societies. In this manner every chemist could get in touch with any other chemist in the world since all addresses will be available at the International Institute.

"Not the least aim of the International

Chemical Institute should be to enable every chemist to obtain copies of published work on any particular subject of chemistry—at reasonable prices. This could be done if the Institute were to prepare a gigantic manual covering systematically all the field of chemistry, and arrange to supply separately chapters of this manual dealing with individual problems.*

"An obvious field of activity for an International Chemical Institute lies in rendering more accessible scientific publications which are published in the less known languages. A bureau of translation will form a necessary part of the proposed Institution. Perhaps this section will eventually develop an international language specially designed for the distribution of chemical knowledge. It may appear at first surprising, but it is nevertheless true, that an artificial language such as 'Ido' is much more readily adaptable to express chemical thought, than any living language. This is no doubt due to its greater plasticity and to the fact that in a special domain such as chemistry the number of concepts and relations to be expressed is comparatively small.

"There are no doubt other matters which will come within the field of action of the International Institute and these will have to receive its attention as they are brought before it."

* The recent improvement in "photostat copying" subject to certain changes in copyright law, simplifies considerably this undertaking. Certain scientific societies are already able to supply to their members photostat copies of any published article.

IMPORT DUTIES ADVISORY COMMITTEE.

The Import Duties Advisory Committee give notice of the following applications for increased duties.

By Messrs. Guest, Keen and Nettlefolds, Ltd., The British Screw Co., Ltd., and Henry Cox Screw Co., Ltd., in respect of wood-screws of iron or steel or non-ferrous metal.

By the Master Gold Beaters and the Gold Beaters' Trade Society, in respect of gold leaf.

By the Paper Makers' Association of Great Britain and Ireland, in respect of packing and wrapping paper and articles made therefrom.

By the Fertiliser Manufacturers' Association, Ltd., in respect of superphosphate and compound fertilisers.

By the Federation of British Industries, in respect of such hair combs as are not already subject to additional duties.

By the India Rubber Manufacturers' Association, Ltd., in respect of rubber footwear.

The Committee are also considering an application for the adjustment of the duties on paints and colours by substituting the following for the existing class of goods dutiable upon Group X (29) of the Additional Import Duties (No. 1) Order, 1932.

Paints, painters' enamels, lacquers, varnishes and printers' inks; distempers, whether dry or not; pigments (whether dry or ground in oil or other medium) other than synthetic organic dyestuffs, colours and colouring matters, dry earth colours, barytes, and carbon black from natural gas.

The Committee also give notice of an application for the addition of magnesium metal and magnesium alloys to the Free List and an application for the reduction of the duties on wicker baskets.

Any representations which interested parties desire to make in regard to these commodities should be addressed in writing to the Secretary, Import Duties Advisory Committee, Caxton House (West Block), Tothill Street, London, S.W. 1. not later than the 7th July.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

Thursday, June 9, 1932, at 4.15 p.m.

A Portrait of Lord Rutherford, painted by Mr. Oswald Birley, was presented to the Society on behalf of the subscribers by the Earl of Crawford and Balcarres.

At 4.30 p.m.

THE BAKERIAN LECTURE:

"THE COMBUSTION OF HYDROCARBONS."

(With Experiments.)

BY

PROFESSOR WILLIAM A. BONE, F.R.S.

Abstract only: further details will be pub-

lished in a future issue of the *Chemical News.*

The principal researches and theories concerning the chemical mechanism of hydrocarbon combustion, from the time of John Dalton until now, are reviewed and discussed in three sections, namely: (I) *Nineteenth Century Discoveries,* showing how the successive theories of preferential combustion, whether of hydrogen or carbon, failed: (II) *Development of the "Hydroxylation" Theory* (1900-1915), together with the relevant experimental evidence from both slow and explosive combustion supporting it; and (III) *Recent developments—"Hydroxylation" v. "Peroxidation,"* in which the two theories will be discussed in the light of both old and new experimental evidence.

The experimental part of the review will include demonstrations of (i) the superior affinities of hydrocarbons over hydrogen for oxygen, as shown by $C_2H_2 + O_2 + 2H_2$, $C_2H_4 + O_2 + H_2$ explosions, (ii) the characteristic explosions of $CH_4 + O_2$, $C_2H_6 + O_2$, $C_2H_2 + O_2$ and $C_2H_4 + O_2$ mixtures; and (iii) characteristic differences between the behaviours of $C_n H_{2n} + \frac{n}{2} O_2$ and $C_nH_{2n+2} + \frac{n}{2} O_2$ mixtures on explosion—all constituting the principal facts of explosive combustion which have to be accounted for by any valid theory of hydrocarbon combustion.

At a meeting on Tuesday, June 16, the President opened a discussion on "Recent Advances in the Study of Enzymes and their Action."

THE PHYSICAL SOCIETY.

The Seventeenth Guthrie Lecture to the Physical Society was delivered on June 17th at 5 p.m. at the Imperial College of Science and Technology, South Kensington. Dr. Max Planck, (formerly Professor in Berlin), is this year's lecturer, and his subject will be "The Concept of Causality in Physics." Professor Planck is famous for his contributions to thermodynamical theory and its applications, and above all as the author of the quantum theory. He was naturally led to the study of the problems of black body radiation by his preoccupation with thermodynamical questions, and his success in solving these problems—or rather the comprehensive and fundamental problem of the energy distribution—was partly due to his recognition of the fact that the observed energy distribution was incompatible with classical principles, and also that Boltzmann's notion of entropy needed something in the nature of discontinuous energy interchange to give it precision.

The subject of Planck's doctoral dissertation (1879) was the Second Law of Thermodynamics, and from that time onward he has published an immense number of papers, some of them devoted to the clarification of thermodynamical theory, and others to the application of thermodynamical principles to all manner of problems. The contents of these papers are substantially contained in his great treatise, *Vorlesungen über Thermodynamik,* probably the best work hitherto published on this subject. In reading this book one feels how strong is the author's instinct for satisfactory theoretical foundations and a logically coherent superstructure.

As long ago as 1896 W. Wien, a countryman of Planck's, published a formula which represented the observed energy distribution in the spectrum of black body radiation exceedingly well for small values of $\lambda\tau$. Somewhat later the late Lord Rayleigh arrived at a different formula, which fitted the observational data very well so long as $\lambda\tau$ was large. Moreover Rayleigh's formula appeared to Planck to be an inevitable consequence of classical dynamics and his problem was therefore to derive a formula which would coalesce with Rayleigh's for large $\lambda\tau$ and differ inappreciably, if at all, from Wien's for small $\lambda\tau$. This problem he solved by the hypothesis of simple harmonic oscillators, which emitted or absorbed energy by small *quanta, hv,* in which *h* represented the now familiar constant called by Planck the *quantum of action.* The classical law of equipartition of energy would make the average energy of such an oscillator (assuming one degree of freedom and temperature equilibrium) equal to $k\tau$, where k is another constant (Boltzmann's constant) which may be described, inadequately but not inaccurately,

as the "gas constant" per molecule. Planck's innovation was equivalent to replacing $k\tau$ by $h\nu/(e^{\frac{h\nu}{k\tau}}-1)$. The data furnished by Kurlbaum, Lummer and Pringsheim, Paschen and others enabled Planck to evaluate both of the constants k and h. From the former he computed Loschmidt's (Avogadro's) number to be 6.2×10^{23} molecules per gram molecule, and for the elementary ionic charge he found 4.67×10^{-10} E.S.U. This wonderfully accurate estimate of the elementary charge, from data provided by observations of black body radiation and by electrolytic measurements, must be regarded as one of the most remarkable achievements in the history of physical science.

Planck's great papers on the energy distribution in the normal spectrum are contained in the *Verhandlungen der Deutschen Physikalischen Gesellschaft*, 2, pp. 237-245, 1900; and in the *Annalen der Physik, 4*, pp. 553-563 and pp 554-566, 1901. He has also dealt at great length with the subject in his book *Verlesungen über Wärmestrahlung.*

The quantum theory like most other *great* things, was not received with much cordiality. It is doubtful whether anybody but Planck himself believed in it in the early days. Indeed we know that as late as 1908 or 1909 the most desperate expedients were invoked to reconcile the sacrosianct Newtonian dynamical principles and the rebellious facts of black body radiation and photo-electricity. Planck has long since triumphed, and his work, and that of his pupils and successors—among whom is his successor in the Chair of Theoretical Physics at Berlin, Dr. E. Schroedinger—has made the quantum theory a coherent structure, as impressive in its magnitude as the theory of relativity and much more profound in its significance.

Correspondence.

"PRESENT-DAY TRENDS IN THE STUDY OF THE STRUCTURE AND NATURE OF THE UNIVERSE."

To the Editor of the *Chemical News.*

DEAR SIR,

May I be permitted to raise a question, as a chemist, in connection with the above-mentioned lecture of Dr. Blood Ryan (*Chemical News*, vol. CXLIV, No. 3763/4). Chemistry and physics, however, closely connected for the rest, may be considered as separate subjects, parts of the general natural science. This lecture concerns general science. A change in the idea of general concepts, particularly of time and space, can also be of significance for the parts of our science. This is here quite clear since Einstein's work concerning the idea of space and time finds its origin in physics—as I believe I can show, in the Michelson experiment—and is therefore of much importance in physics. My question, put as a chemist, is this: do Einstein's *ideas of space and time also affect chemistry* or in other words: *is Einstein's theory of relativity necessary for chemistry?*

Since this question has a very general purport and I have myself given much time to this question, I may be permitted to give a provisional brief answer to it. In so doing, I hope to prevent our arguing at cross purposes by stating more precisely what I mean.

Let us, in order to give our thoughts a more concrete form, take *organic* chemistry as our subject. What has been the aim of this branch? To build up all compounds occurring in nature in living organisms from the constituent elements in a simple synthetic way.

Has this aim been attained?

Certainly! One might say for at least 99 per cent.

And this success has been so striking and surprising; the goal aimed at has been so completely reached, that various prominent thinkers consider this branch of science as practically the most exact branch of our natural knowledge.

What now is the fundamental principle of organic chemistry?

The localisation of the atoms in the molecule. We have arrived at being able, so to speak, to point out for each atom its place in the molecule. Has this anything to do with Einstein's relativity? Time is measured duration, space is measured distance. As long as we attach no definite picture to the velocity of the atoms in the organic *molecule and to the relative distances and* dimensions of the atoms—as long as we include in our discussion only the relative positions of the atoms with respect to one another, so long do we remain outside more special views of time and space, this is outside Einstein's relativity as can readily be seen.

In this case the answer to our question is; *is Einstein's relativity necessary for chemistry? No!* Organic chemistry, as an exact science, has certainly not needed Einstein in order to reach its goal.

Now you will say: I want to dig deeper, the atom plays a part in your molecule and this atom must also have a structure, is not Einstein's relativity then necessary for this atom?

My answer is then as follows:

What idea have you of the atom? What atom model do you prefer?

The Rutherford-Bohr model!

That model is *not* chemical!

Since first of all this model pre-supposes a

structure of the atom similar to a sun and planet system, something which we do *not* know in chemistry. A chemical model ought indeed to have a shape similar to our molecule, in other words: in a chemical model the atom must be built up from its constituent parts, the protons, like a molecule is built up of atoms.

In a chemical model we shall have to surmise the position or arrangement of the protons.

Secondly, Bohr, by introducing the concept of electricity, which has *not* been explained fundamentally, into the atom, arrives at a complexity and a vagueness which we do *not* know. That also is *not* chemical!

When then is a *chemical* model satisfactory?

When we can explain specific chemical properties of matter with its aid. That is to say, that our model, according to our way of thinking, which is based on organic chemistry, ought to explain Mendelejif's Table, *viz.*, the atomic weight, the atomic number and the column number (valency).

And . . . . shall we then need Einstein's relativity?

No—if we do not go further into the structure of our atom from protons than in the structure of our molecule from atoms, if we thus make no special premises about velocities and dimensions.

By this means we can also explain the atom chemically in a satisfactory manner . . . . *without Einstein.*

But you will now still say:

Without *light*, you cannot even think of chemistry.

I will let this pass without further discussion and only remark that a *chemical* view of light can also be thought of. With this we return to Dr. Blood Ryan's starting point: the Michelson experiment.

My explanation of this experiment is the following: the interference bands are of secondary importance and are caused by the technical imperfections of any apparatus. If the two light-paths in the apparatus were theoretically perfect, *i.e.*, exactly equally long, then we should see no interference fringes at all. *The null-effect would then be absolute.* We should see nothing at all. And why not? Because protons are emitted and the emission theory of light demands a null-effect in the Michelson experiment. Thus this—your starting point—is also simply and well explained, on the present-day knowledge of light in the old-fashioned manner of before Einstein.

Finally I repeat my question:

Is Einstein's relativity necessary in our chemical thought?

As long as we keep to a purely *chemical* atom model—*no.*

May I herewith express my thanks for the hospitality extended both by the old as well as the new editorial staff of the *Chemical News* to the discussions I have published under the title of *Matter and Logic.*

DR. W. TOMBROCK.

DEVELOPMENT OF EXPORT TRADE—GROUP SELLING.

To the Editor, *Chemical News.*

DEAR SIR,

The question of group selling for export or, in other words, arrangements by British manufacturers for joint representation in overseas markets, has received increasing attention both in the Press and by those concerned with export trade.

I recall in particular the appeal made by H.R.H. the Prince of Wales, on his return from South America last year, for cordial co-operation by industrial units and for more grouping, particularly as regards salesmanship and representation.

The object of such grouping is to assist those manufacturers who cannot individually afford to maintain full-time representatives abroad, to secure the substantial measure of direct representation which is of such importance in connection with overseas marketing.

The British Export Society—which is an organisation for the purpose of dealing in a practical manner with the problems of Export Trade—has had under consideration this problem of overseas group selling and has drawn up a pamphlet on the subject containing a preliminary survey of the underlying principles—viewed from a practical standpoint. Mr. John Colville, M.P., Parliamentary Secretary of the Department of Overseas Trade, has written a foreword to this pamphlet, of which a copy is enclosed for your information.

The Society is prepared, in addition, to assist the practical promotion of suitable selling groups. In order, however, to produce the best results, the Society feels that its activities in this matter should be restricted to its own membership, as there are doubtless many non-member firms which would welcome an opportunity of discussing the problems with other firms similarly interested. Indeed, the lack of co-ordinated thought and action has, in the Society's opinion, hitherto seriously retarded this important development.

I shall, therefore, be glad if you will make it known to your Readers that the British Export Society voluntarily offers its facilities to all exporting British firms (whether members of the Society or not) to bring them into touch with other firms producing or handling non-competitive British products, with a view to their co-operation in the formation of Selling Groups. The Society extends this offer in the general interests of British Export trade, the development of which is of such vital importance to the country.

Any firms interested should place themselves in communication with The Secretary, The British Export Society, 21, Tothill Street, London, S.W. 1, from whom copies of the pamphlet can be obtained.

Yours faithfully,
HUGO HIRST,

Notices of Books.

Osiris and the Atom, by J. G. Crowther, London. George Routledge & Sons Ltd. 5/-. Pp. viii + 220 and plates.

This collection of essays is conceived in the vein of the *Science for You* series, and is "intended to be a record of some of the more striking recent advances in science, written in a simple style for the general reader."

It is not perhaps easy to estimate the effect of the stories presented here, undoubtedly in simple language, on the untrained mind, but it would seem that the author has succeeded very well in his task.

One interesting section is devoted to an appreciation of some of the greater minds of science—Clerk Maxwell and Faraday from this country, and Haber and Gropius, (sic), the architect, from the Continent. In another, reference is made to the remarkable efforts made in Germany to find scope for the less conventional minds, in the Kaiser Wilhelm Gesellschaft. These, which are too often frittered away in despairing efforts to find an outlet, may nowadays in Germany be properly fostered: and thus their quota of scientific progress is secured to the world. The actual results achieved should give other nations—particularly the English—furiously to think. That part of this book might well be brought forcibly to the notice of our wealthy (potential) patrons of science.

A very striking chapter is devoted to the great meteorite of 1908 in Siberia, which was so strangely ignored by the world for many years.

Of considerable practical interest is the article on the proposed use of "basic English" as a universal language. The article itself is written with the use of these basic words only, though this fact is unnoticed until the statement is made at the end of it: this alone is sufficiently evidential of the possibilities of this 800-word language.

For the uninitiated, an interesting survey of the things about which men of science are to-day concerned: for the specialist, a useful insight into other men's work.

A. H. B.

NEW GERMAN BOOKS.

Die Vitamine, by Prof. Adolf Jolles. Pp. viii + 157. Leipzig & Vienna: Verlag von Franz Deuticke. 1932. Price 10 marks.

Prof. A. Jolles of Vienna is engaged upon a series of works dealing with the scientific basis of nutrition. His first volume appeared in 1926, and contained a general survey of foodstuffs. Now we have the second volume which deals ably with the Vitamines from the standpoint of the biochemist. The author begins with an account of the energy cycle in the organic world and then goes on to discuss the rates of reactions and the influence of various factors upon them. From a description of enzymes Prof. Jolles proceeds to their specific physiological and chemical behaviour and we are introduced to the diseases arising from a diet lacking in one or more accessory food factors, *i.e.*, the vitamines. The hormones are next discussed and the evaluation of different vitamine preparations is given.

The book, which may be cordially recommended to biochemists and others, concludes with remarks on vegetarianism and diet generally. We are promised volumes on Proteins, Fats, Carbohydrates, Inorganic Foods and Metabolism. These will be awaited with interest.

Über eine neue Klasse von Verbindungen des positiv einwertigen Jods, by Dr. Heinrich Carlsohn. Pp. iv + 63. Leipzig: S. Hirzel. 1932. Price 2 marks, 50 pf.

In this interesting monograph Dr. Carlsohn has collected together a mass of evidence to show that in IOH the iodine can behave as a monovalent kation, particularly in co-ordinated compounds (*e.g.,* those with pyridine).

Die Werkstoffe der chemischen Apparate, by Dr. H. Freytag. Pp. 54. Berlin: Verlag Chemie. 1932. Price 2 marks, 80 pf.

Dr. Freytag, who is a distinguished German chemical engineer, has compiled a most useful list of the metals and materials which can and cannot be used for making plant for use with the respective chemical elements and those of their compounds which are commonly used in industrial processes. He has included, too, quite a number of the organic substances now so largely employed in the chemical, metallurgical and engineering trades. There are so many resistant alloys masquerading under manufacturers' names that the list given by Dr. Freytag, although mainly German products, will be valuable to chemical engineers, works' chemists and others. Modern needs in the chemical industry definitely necessitate the employment of the most suitable plant for each individual process and it is with this in view that the author has written his very useful volume.

The June issue of the *Recueil des Travaux chimiques des Pays-Bas,* is dedicated to the jubilee of Prof. A. Smits, whose work on allotropy is so well known. This number contains some two dozen papers, several of which bear close connection with the researches of Prof. Smits.

Prof. P. W. Bridgman gives an account of a transition of silver oxide under pressure. The exact nature of the transition has, apparently, not been definitely elucidated although it appears that other solids which crystallise in the cubic system behave in the same way.

Among the other papers appearing in this special issue of the *Recueil are the following*:—J. Rinse, The refractive index of tung oil. H. I. Waterman and T. W. te Nuyl, Preparation of pure octene. J. P. Treub, The Mathematical representation of the course of chemical reactions. F. A. H. Schreinemakers, Osmosis in binary systems. G. Meyer and F. E. C. Scheffer, The equilibruim

$Sn + 2CO_2 \rightleftarrows SnO_2 + 2CO$
E. H. Buchner, Influence of salts on the viscosity of hydrophilei colloids and J. P. Wibaut and J. van Dalfsen, addition of HCl to acetylene and to vingl chloride in the gaseous phase under the influence of catalysts.

A MOSQUITO SUMMARY.

Under the above title Mr. John F. Marshall, Founder and Director of the British Mosquito Control Institute at Hayling Island, has published, a pamphlet (Price 9d.) summarising the main facts relating to the Life, History, Habits and Control of Mosquitoes. He has presented the subject in a manner readily intelligible to anyone possessing the merest elementary knowledge of biology so that the information concerning mosquitoes and the most efficacious manner of keeping them under control may be available for health authorities, travellers and others as well as for biology students. The pamphlet is illustrated with seven figures and photographs and together with the text gives an adequate account of the subject. The mechanism of mouth of the female mosquito enabling it to bite and thereby transmit disease (*e.g.,* malaria) is very clearly set out and so is the account of the way in which the parasite *Plasmodium* is carried from an infected body to another (healthy) person.

As Mr. Marshall says, we can prevent mosquitoes from breeding by doing away with standing water or by setting the water in motion and, where necessary, by removing surface weeds. Before the application of oil or cersylic preparations are used it should be ascertained whether the larvæ of the mosquito are being already controlled by fish, water bugs, water-beetles and other aquatic fauna which destroy or keep down the *Anopheles* and *Culicines.*

New Patents.

These particulars of New Patents of interest to readers have been selected from the Official Journal of Patents and are published by permission of the Controller of H.M. Stationery Office, and the Official Journal of Patents can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

Latest Patent Applications.

15,981.—Baxter, J.P., & Imperial Chemical Industries, Ltd., & Weil, J. A.—Production of sulphur dioxide. June 6th.

16,181.—Fischer, H.—Regenerating waste sulphuric acid. June 8th.

16,360.—Mather, L. C.—Manufacture of sulphuric acid. June 10th.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, at the uniform price of 1/- each.

Abstract Published.

Group Abridgements can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, either sheet by sheet as issued on payment of a subscription of 5/- per Group Volume or in bound volumes price 2/- each.

368,348.—Acetic acid.—British Celanese, Ltd., 22, Hanover Square, London, Oxley, H. F., and Groombridge, W. H., of British Celanese, Spondon, near Derby.

In the oxidation of liquid acetaldehyde by air or oxygen for the production of acetic acid, the concentration of the acetic acid in the reaction mixture is maintained at a point not exceeding 70 per cent.; for instance, it may be maintained at 50-70 per cent. by additions of acetaldehyde. A known catalyst may be used, such as manganese acetate, uranium oxide, ferric oxide, ferric acetate, chromium oxide, vanadium pentoxide, or the catalysts described in Application 367,863 (manganic salts) or in Specifications 154,304 and 154,680, [both in *Class* 2 (iii), Dyes &c.] (china clay or kaolin or the residue left on calcining animal charcoal or mixtures thereof with sodium acetate), and normal, reduced, or increased pressure may be employed. The oxidizing gas may be introduced in fine bubbles, with agitation and the temperature may be from 0 to 40° C. or more. Cooling to 0-5° C. may be employed advantageously during the initial stages and/or intermittently during the process. The reaction vessel may be provided with a condenser, and the escaping gas may be scrubbed with acetic acid or with some of the reaction liquor, and the liquor returning to the reaction vessel may do so in the form of spray. Catalyst may be added with the aldehyde continuously or intermittently. The acid may be freed from aldehyde by heating or fractionation and further distilled with or without permanganate. Specification 366,022 also is referred to.

The Latest Trade Marks.

This list of Trade Marks of interest to readers has been selected from the Official Trade Marks Journal and is published by permission of the Controller of H.M. Stationery Office, and the Trade Marks Journal can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C. 2, price 1/- weekly (annual subscription £2 10s. 0d.).

HUMOGUANINE.

531,775.—All goods in Class 2 which includes chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Eric Barkeley Higgins, 125, High Holhorn, London, W.C. 1. June 15th.